THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 63 Thursday, August 8, 1940 No 1251

PUBLISHED WEEKLY

Subscription Terms (Home and Overseas) : 21s. per annum.
All Subscriptions are payable in advance.

THE FOUNDRY TRADE JOURNAL
49, Wellington Street, London, W.C.2.

EMERGENCY ADDRESS
to which all communications should be sent until further notice :—
3, Amersham Road, HIGH WYCOMBE, Bucks.
Telegraphic Address : "Zacatecas, High Wycombe."
Telephone : HIGH WYCOMBE 1792 (3 lines).

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Transport Co-ordination

Waste of any kind must be avoided in wartime. No industry is more essential than that concerned with transport, so a Committee was appointed by the Minister of Transport to consider whether more efficient services could be provided by the allocation of traffic. The Report of the Committee—of which Sir Arthur Griffith-Boscawen was chairman, assisted by representatives of the four main forms of transport—has now been published. At the outset, the Committee says that all four forms of transport should be used to the fullest possible extent, but that each form should be so maintained that it may be able to resume its normal position on the return of peace. This sentence refers, no doubt, to the railways, which were handed back to their proprietors after the last war with their running expenses so swollen under Government control that no net revenue was left.

At present there is no control of the division of traffic between the four forms, except that the restrictions on imported oil and petrol have cut down the operations of road vehicles. In the case of coastwise shipping the Ministry of Shipping has a direct control over the ships, and indirectly over their cargoes. Other Ministries such as those of Food and Supply have also a certain amount of control, but all this is piecemeal.

What the Committee suggests is some effective national control over the wartime distribution of function between the four branches of goods transport. Such control and division may be either compulsory or voluntary; the Committee would prefer a voluntary division. Local knowledge is essential, so the Committee proposes the setting-up of a central committee assisted by local committees. The central committee should consist of representatives of the four forms of transport, with an additional member to represent the ancillary users, together with members appointed by the Ministers of Transport and Shipping; an independent chairman, possibly a whole-time office, should be appointed by the Minister of Transport.

Lord Bryce used to say that all government is really local government, so this central committee should be assisted by regional committees in each Civil Defence Region. Traders need not be represented on the regional committees, who would not impose direct restrictions on the consignors of goods. Negotiations with traders and problems affecting labour should be left to the central committee. The main duties of the central committee would be to advise the Minister of Transport, and in particular to plan the best use of transport and the allocation of traffic in advance of the occurrence of any serious emergency—a reference, no doubt, to Hitler's anticipated invasion.

One of the duties of the regional committees would be to effect local agreements, which would necessarily take account of the motor fuel available; here they would have to keep in touch with the Regional Transport Commissioners. All these bodies should have regard to every relevant situation, including the cost of transit. This is a large question, since no one has worked out the real cost of transporting goods by road and rail respectively, mainly because it is almost impossible to decide how much of the cost of carrying a consignment should be allocated to the permanent way in each case. Any traders should be allowed to appeal against local agreements to the regional committee, and possibly to the Minister.

Canal owners would like to be taken over by the Government, with a guarantee of net receipts, a proposal which the Minister has refused.

Balancing Industry

A lead has been given to industry in general by the Ironfounders' National Confederation by the dispatch last Friday of a questionnaire to its members. Its object is to ascertain and bring to the notice of the Government Departments the idle capacity of the ironfoundries and the nature of their requirements to bring them up to full-scale production. Ten main questions are asked and the answers can be given by any foundry executive in five minutes, yet after assembly they reveal information of real value to the Ministry of Supply, especially in case of damage by fire or military action. One question—"Have you any idle capacity, if so state tonnage? "—is obviously one of continuous interest and to keep the system alive, this figure should be reported at frequent intervals. However, firms should have sufficient business acumen to keep the Confederation posted as to any major changes they experience in business fluctuations. The balance of the information given by the questionnaire will, generally speaking, serve for the duration. The general operation of such a scheme will tend to create an efficient and balanced industry.

C

Stress-Strain Relations for Malleable Iron in Tension

In a Paper which MR. R. D. LANDON presented to the annual meeting of the American Society for Testing Materials, held at Atlantic City, N.J., the physical behaviour of 141 tension specimens of malleable cast iron covering a wide range of carbon content was recorded and, based on the results, changes in the standard testing procedure were suggested for consideration. The author has summarised his conclusions as follows:—

Turned specimens had practically the same modulus of elasticity and stress at elongations of 0.005, 0.010 and 0.020 in. in 2 in. as did specimens "as cast" but the former had slightly lower values of ultimate stress and percentage elongation. There was no drop of the beam of the testing machine during any test and reference to such occurrence should be deleted from the A.S.T.M. specifications.

The best values of elongation for determining "yield point" appear to be either 0.010 or 0.020 in. in 2 in. If the smaller value is used, an instrument of greater accuracy than dividers and scale should be used for measurement.

Malleable iron has no true yield point and in order to conform to A.S.T.M. definitions the term "yield point" should not be used. A suggested term, both correct and descriptive, is "proof stress."

The characteristics of malleable iron as determined in this series of tests indicate that the proof stress might better be specified as a percentage of the ultimate stress rather than as an arbitrarily fixed value.

Many specimens were eccentric or out of round in the grip sections owing to the presence of metal from sprues and risers. In some cases large identifying marks on the grip sections precluded pulling without introduction of eccentric forces. A considerable number of specimens failed to have a straight axis of generation (that is, they were bent). Naturally all of these physical defects have their effect on the accuracy of results and penalise the material under test. More explicit specifications for moulding, casting and inspection should pave the way toward improved test specimens.

Further consideration of the data and results should lead to additional conclusions and further tests should be conducted by other investigators on specimens from the same and other sources.

Effect of Rate of Strain on Results of Tension Tests

MR. PAUL G. JONES and PROF. H. F. MOORE, in a Paper which they presented to the annual meeting of the American Society for Testing Materials, in Atlantic City, N.J., detailed the results of tension tests of 14 alloys using different speeds of testing. The apparatus used was autographic and employed a duplicate apparatus for weighing the load—a compression block with a carbon-pile compressometer and, in series with it, a steel tension weighbar with an electric resistance extensometer. The stretch of the specimen was measured by means of an electric resistance extensometer. Time records were made photographically on an oscillograph film by contacts fitted to an electric clock.

The results of the tests showed appreciable effect of rate of strain on the tension test results, but, except for the stainless steel specimens, the amount of this variation might be expressed by the statement that doubling the rate of strain would introduce a variation not greater than 1 per cent. in value of yield strength or tensile strength and not greater than 3 per cent. in elongation or reduction of area, with the exception of elongation and reduction of area for the brittle cast metals tested.

Non-ferrous Metals in Steelmaking

According to the American Iron and Steel Institute, for every ton of steel produced, the steel industry purchases about 30 lbs. of non-ferrous metals for use as ingredients in steel or for coating finished steel products. When United States steel operations are at 70 per cent. of capacity, the industry annually consumes for those purposes a total of 675,000 tons of metallic aluminium, chromium, copper, lead, manganese, molybdenum, nickel, tin, tungsten, vanadium, and zinc. The total does not include the amount of aluminium, copper, lead, and some of the other metals which may be purchased for other than metallurgical purposes, nor does it include the non-ferrous metals in purchased equipment.

More than four-fifths of the industry's total consumption of non-ferrous metals consists of manganese and zinc. Operating at 70 per cent. of capacity, the steel industry buys about 329,300 tons of manganese metal and 220,100 tons of zinc per year. Manganese comes chiefly from Russia, Africa, Brazil, Cuba, and India, and its principal use in steel is to remove gases from the steel. The United States is the chief source of supply for zinc, used as coating for galvanised steel products.

At 70 per cent. operations, an average of 42,000 tons of tin and 5,600 tons of lead are purchased annually. British Malaya, England, and Netherlands Indies supply most of the tin, while the lead is produced in the United States. About 3,800 tons of copper and 3,400 tons of tungsten are consumed annually. The United States is self-sufficient in copper and produces some tungsten, but most of the tungsten consumed is imported from China and British Malaya.

The United States have ample resources of molybdenum, about 2,200 tons of which are consumed at 70 per cent. steel-plant operation, while a substantial part of the 500 tons of vanadium required annually at that rate of activity is obtained from within the United States. Vanadium is also imported from Peru and Rhodesia.—"The Iron Age."

Cupola Research

The American Foundrymen's Association have just initiated a large-scale co-operative research project into the theory and practice of cupola operation. The main committee is to be presided over by Mr. A. L. Boegehold, head of the metallurgical department of the Research Laboratories of the General Motors Corporation, Detroit. The committee and sub-committee include the names of more than a hundred foundry experts.

For the prosecution of the research, the structure of the organisation is as follows: Executive Committee; (1) Equipment; (2) Ferrous Materials and Alloys—(*a*) Pig-iron, (*b*) Scrap, and (*c*) Alloys; (3) Slags, Fluxes and Desulphurisers; (4) Fuels and Combustion; (5) Operation and Process and (6) Refractories. The project is expected to take about five years to complete.

Dolomite and Brucite-Marble in the Highlands

The Department of Scientific and Industrial Research has issued on behalf of the Geological Survey of Great Britain, Wartime Pamphlet No. 6, "Dolomite and Brucite-Marble in the Scottish Highlands," by MR. W. Q. KENNEDY, D.Sc. The publication deals not only with dolomite and its location at Durness, Eireboli, Assynt, Loch Kishorn and Isle of Kyle, but with the Appin Limestone formation in Duror, Argyllshire; also with brucite-marble at Assynt, Sutherland and the Isle of Skye, Inverness-shire. The brochure includes a number of maps indicating the position of these materials.

Random Shots

It is disheartening, on getting out one's white flannels, to find that the moths have got to the drawer first! Such was the cause of the slight despondency with which "Marksman" started out to business one day last week, for the mind (no more than the moth) would not rest on the one discovery. If flannels, why not dress suit also? And if dress suit, it was only reasonable to suppose that the destructive creatures had found last winter's overcoat, too.

* * *

It was but a short step from dwelling upon the ravages of one pestilent enemy to thinking of another pestilent enemy very busy in Europe at the present moment, this time of the human species . . . and upon this score it was not right or needful to be despondent, for on the wall outside "Marksman's" suburban station, instead of the one-time Fascist or Communist sign (usually alternating with a cheerful nicety), was chalked up in large lettering, "Churchill and the boys will see us through!"

* * *

The obvious mental reaction to that sight was "that's the stuff to give 'em." It was a happy coincidence, then, that there should be waiting for "Marksman" in his office a letter from a Scottish foundry manager, which had written all over it, so to speak, those very words!

* * *

It recounted an incident which took place one Sunday afternoon at the writer's works between two conscientious objectors who quarrelled because one accused the other of being "yellow." The argument proceeded from words to action, which led them finally to the back of the foundry to fight it out in the open. They fought so long and they fought so well that in the end neither could lift his arm to go on with it. One slunk away to be mended at home, presumably, whilst the other had to receive careful attention at the works' first-aid station.

* * *

The moral, the writer points out, is that if a couple of professed pacifists will fight with such vigour and spirit over their convictions, how much more spirit can be expected from the fighting forces!

* * *

Incidentally, mention of white flannels makes one think of cricket and to wonder now that the match is being played on the home ground, if in the Air Force twenty is considered a good score?

* * *

It is reported that "Somewhere in England" there is at least one "Stop me and buy one" merchant who intends to make money out of air raids. Ever since the occasion upon which he accidentally found himself sharing an air-raid shelter with a company of Czech generals, French officers and British naval men, with whom he did a very brisk business in "tuppenny blocks," he has spent his time hovering near that same hotel in hope of repeating his success!

"MARKSMAN."

Industrial Application of Ear Plugs

Optrex, Limited, Wadsworth Road, Perivale, Middlesex, have sent us a sample of their rubber ear plugs. They are anatomically designed to fit snugly into the aural cavity and are inconspicuous. Whilst the obvious use at the moment is as an air-raid precaution, there is an industrial application meriting consideration. It appears that excessive noise seriously lowers industrial efficiency, probably through some deleterious effect upon the nervous system, and it is suggested that the wearing of washable, durable rubber plugs, designed for right and left ear use, will mitigate matters. An obvious place for experiment within the foundry industry is in the jar-ramming section of the moulding floor.

Production of Pressure-Resisting and High-Duty Iron Castings

A further contribution to the written discussion on the Paper by Mr. J. L. Francis, entitled "Production of Pressure-Resisting and High-Duty Iron Castings," prepared for presentation to the Institute of British Foundrymen, is printed below. The Paper was reproduced in our issues of June 20 and 27 and July 4.

MR. H. W. KEEBLE (works metallurgist, Wm. Mills, Limited, Birmingham) wrote:—I have read the Paper with interest and profit. I developed a feeling that if all foundries on this class of work operated with the same degree of control there would be less call on the local drysalter's stock of sal ammoniac, and fewer occasions for the machine-shop people to cover their own failings to fulfil schedules by the indiscriminate use of the excuse, "trouble of weeping at pressure test."

I note that Mr. Francis works with cupolas fitted with receivers; further, that he arranges his "blow" so that he commences with ordinary grade iron which changes progressively to high-duty grades and then back again to the ordinary grades. Perhaps Mr. Francis would outline his reasons for this procedure, as from the compositional aspect it would seem more straightforward to work from ordinary grades up to the highest grade and then finishing. Presumably such factors as local floor conditions of coring-up, closing, availability of ladles and peculiarity of cupola operation, etc., affect the issue. The two sets of conditions are shown graphically in Fig. A.

The author stresses the necessity, and rightly so, of timing the charges through, and I would like to have his opinion of supplementing this control by use of the wedge chill test. Under the best of conditions emergencies arise, such as scaffolding, etc., which might render timing control alone somewhat inadequate.

The use of high manganese contents by Mr. Francis (that is, around the 1 per cent. mark) for high-duty work is to be recommended and is based on sound metallurgical principles. It would be to advantage if this practice were more widely followed. Fifteen years ago the "all-pearlitic" structure was the fashion in cast-iron metallurgical circles. As was expressed at that time, the next phase of development would be the attainment of sorbitic structures, and in this manganese plays a part. The 1940 A.F.A. "Cast Metals Handbook" says: "As manganese content of cast iron is increased the matrix is successively pearlitic, sorbitic, martensitic and austenitic. In a pearlite iron, an increase of manganese from, say, 0.4 to 0.7 per cent. would affect structure very little. With an increase up to, say, 1 per cent. the matrix would be expected to appear somewhat sorbitic." High manganese facilitates use of ordinary base irons and machinery scrap for manufacture of high-duty irons.

I would like to have the author's opinion on one aspect of high-manganese practice. With pig-irons containing high manganese, phosphorus and silicon (like pig-iron A, Table I of the Paper), I have noticed that primary as well as secondary graphite is much in evidence. The author recognises the possible effect of this, for he says: "Charge materials having an excess of coarse graphite tend to retain this characteristic even after passage through the cupola." Does he have any trouble on this account from high-manganese pig-iron?

With respect to the moulding technique for the cast-iron rotor, it is noted that the shouldered portion of the machined densener rod is coated with loam. Is this shoulder portion serrated to carry the loam, or is twine, etc., used as a bonding medium? Also, is any dressing applied to the remaining length? Most foundrymen think of "blowing" troubles when metallic denseners or inserts are mentioned. One of the causes is undoubtedly the sweating of the chill, brought about by water condensate forming on the densener surface. Premature closing of warm moulds, striking back of skin-dried moulds, etc., are among causes of condensate formation. On the other hand, I feel that insufficient attention is given to the scientifically verified fact that certain compositions of cast iron will readily give off gas when heated beyond 700 deg. C. I am referring to the work of Genders and Bailey, Research Monograph of the B.N.-F.M.R.A., pages 115 to 118.

These workers demonstrate that gas is given off in appreciable quantities, the volume increasing with the combined carbon content. The reaction is vigorous at 750 deg. C. The "blowing" is due to chemical action between the usual oxide film and the carbide of the densener; surface oxidation is necessary between the heatings. White iron is the worst offender and soft grey iron the least. In practice, it is almost impossible to avoid superficial oxidation taking

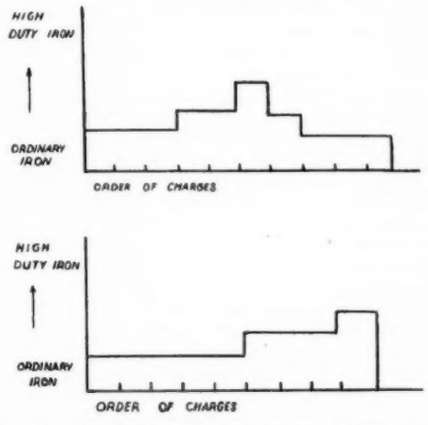

FIG. A.—AUTHOR'S CHARGING SYSTEM (UPPER) AND SYSTEM SUGGESTED BY MR. KEEBLE (LOWER).

place, although the burnt-out dressing provides some protection against oxidation while not being used. When used in the mould, the freshly applied dressing affords some assistance against local overheating by its thermal insulating effect. A machined cast-iron densener is more liable to oxidation than is one possessing the "as-cast" siliceous skin. These facts demonstrate that denseners should be made in soft iron, *i.e.*, of low carbide content, should be used with the "as-cast" skin intact, be dressed, and the metal flow in the mould arranged (as far as possible) so that overheating (beyond 700 deg. C.) does not occur. Under these conditions "blowing" from the densener will be a straight issue relative to "sweating" only.

AUTHOR'S REPLY

MR. J. L. FRANCIS replied: My thanks are due to Mr. Keeble for raising some very interesting points. Apart from his kind remarks in the first paragraph the nature of the contribution reveals that Mr. Keeble has bestowed the compliment of thoroughly studying the Paper.

Reasons for adopting the charge sequence mentioned may be stated briefly as follows:—The demand for high-duty material is usually least in quantity. Optimum melting conditions, in the cupola furnace, tend to occur over a period commencing from the end of the first three or four charges up to a point just before the stock begins to fall at cessation of charging. During this period charges are tapped with chemical composition truer to the theoretical figures calculated from the analysis of their components. Oxidation tends to increase towards the end of the blow and it is not good policy to leave all the most important castings until the last when the ladles are not so clean. In order to conserve the furnace lining as much as possible it is good practice to cease blowing before the last charge has melted and it is preferable for the metal coming down with the "drop" to be of the least costly grade.

Timing Control

Mr. Keeble brings forward emergencies of scaffolding and blast failure he could also have added run-outs. These, of course, should be of rare occurrence only and whilst needing anxious attention it is not desirable to hamper everyday routine melting practice with safeguards intended for operation at rare intervals and which ought to be applied more effectively elsewhere. Actually the timing control is supplemented and checked in practice by employing ladles which have a capacity of at least one charge unit or whole multiples thereof.

The author confirms the utility of the wedge chill test as a means of control but would again emphasise that with comparatively small amounts of high-grade metal time is a factor of vital importance.

In assessing the effect of manganese on cast iron, due consideration must be accorded to the requirements of the manganese-sulphur balance. As explained in the Paper, it is only the manganese in excess of this requirement which is available for exerting the modifications to the structure quoted from the 1940 A.F.A. "Cast Metals Handbook."

With a siliceous pig-iron, such as A in Table I, primary graphite would be expected irrespective of the manganese content. It is intended for use in the lower-grade charges and to carry a high ratio of returns and scrap, the last two items exerting a sufficient refining influence for the purposes intended. Perhaps Mr. Keeble has in mind the tendency of high-manganese irons towards greater carbon absorption. Excess of coarse graphite in the high-duty iron is guarded against by the use of hypo-eutectic irons and running the cupola so as to obtain minimum carbon pick-up. This is explained in the Paper, but a further hint, not mentioned, consists in the charging of fused soda-ash blocks with the bed coke.

Another point with regard to manganese is its introduction to the melt in the form of low-carbon ferro-alloy. Here, because a greater proportion of the manganese is free, that is, not combined as carbide, its action is said to be more intense and the benefits derived are more easily and readily obtained.

Denseners

The points put forward on this subject are well worth studying. Dealing first with the long centre densener used for the bore of the rotor, it is produced as a casting, the shouldered portion cast vertically downwards and formed in a dried sand core. To hold the sand to this portion it is first coated with core gum or slurry. The casting skin is not removed by machining; a dressing of a proprietary anti-scab solution is applied, but a coating of ordinary creosote would do equally well. A cast stick of 2½ in. dia. would not cool very rapidly, so that the combined carbon would not be very high. Thus it seems that most of the requirements summarised in the quotation from the work of Genders and Bailey have been met. Finally, it is not likely, owing to the cross-sectional area of the densener, that it would attain to 750 deg. C. throughout its mass until after the molten metal had formed an appreciable solid skin around it.

D

Fluxes for Welding Aluminium*

By E. G. WEST, Ph.D., B.Sc.

One of the principal sources of trouble in the welding of aluminium and its alloys is the oxide film on the surface of the solid and molten metal. Similar problems arise in the soldering and melting of aluminium-rich alloys.

Alumina (Al_2O_3), existing as a tenacious film on all exposed aluminium surfaces, has a melting point of approximately 2,050 deg. C., high electrical resistivity and considerable mechanical strength. It is also relatively inert towards many chemical substances, and the crystallographic change which occurs on heating appears to be of importance in fluxing reactions. According to a recent investigation (Hütting and Markus, "Kolloid Z.," 88, 1939, pp. 274-288), in which X-ray analysis was used, the γ modification is converted to αAl_2O_3 by heating to temperatures above 850 deg. C. in air. This confirms previous observations but the influence of the atmosphere was also studied, the presence of dried HCl causing the change to take place at lower temperatures. The effects of other gases and mixtures were also determined and the solubility of the resulting oxide in aqueous hydrochloric acid or in fused potassium pyrosulphate was shown to depend on its thermal history.

The oxide film increases the apparent surface tension of molten aluminium, but there is doubt as to the exact extent of the change. According to Portevin and Bastien ("Comptes Rendus," 202, 1936, pp. 1,072-1,074), a film of alumina increases the apparent surface tension of the molten metal from 420 dynes per cm. to 840 dynes per cm. The same authors give the tensile strength of the film as 2 kg. per sq. mm.

Before commencing to weld, the surfaces to be joined should be cleaned, by either mechanical or chemical means or by a combination of the two, and in resistance welding this simple precaution, together with the use of an electrode tip of correct shape, combined with proper control of pressure and electrical power, results in satisfactory joints. During gas and arc welding, however, oxide formation is continuous and rapid and it is essential to remove the alumina before it is entrapped in the freezing metal. Although it is possible in certain cases to remove the oxide by skimming the melt or by puddling out the solid particles, a flux is employed.

All the fluxes in use at present contain essentially alkali fluorides, with chlorides and probably sulphates, carbonates or other salts of the alkali and alkaline earth metals. Traces of the residues of some of these constituents are serious sources of corrosion of the welded joint and adjacent metal. Most of the necessary constituents are hygroscopic but there is at least one which is claimed to be non-corrosive.

Requirements of a Welding Flux

The ideal requirements of a flux may be summarised as follow:—

(*a*) Its melting point should be considerably lower than that of the metal or alloy.

(*b*) The specific gravity in both the liquid and solid states should be lower than that of the molten metal.

(*c*) The solubility of alumina and any other metallic oxides present should be as high as possible at and below the welding or soldering temperature.

(*d*) Properties such as viscosity, surface tension and wetting power should be such that the molten flux spreads readily, in order to ensure oxide solution or absorption. The layer should not be too thin, however, otherwise the volume available is too small to remove the required amount of oxide. The effect of the flux on the surface tension of the molten metal is particularly important in soldering or brazing when the wetting power of the added metal must be at a maximum.

(*e*) The flux layer should be non-porous. The thickness of the layer may affect this property.

(*f*) The flux layer should be impervious to gases which might adversely contaminate the metal.

(*g*) The vapour pressure should be low enough to avoid excessive loss of flux at temperatures up to that of welding or casting.

(*h*) During the welding operation, the composition of the flux should not alter adversely, due to the loss of constituents by volatilisation or reactions.

(*i*) The solution of metallic oxide should not affect detrimentally the desirable properties of the flux, such as specific gravity, viscosity and surface tension.

(*j*) The molten flux should act as a thermal insulator to conserve heat during welding.

(*k*) No constituent of the flux or products of reactions should dissolve in the molten metal, if this results in a deterioration of the properties of the liquid or solid metal.

(*l*) If necessary the flux should be capable of conveying to the melt addition elements, intended to improve the mechanical and other properties of the joint either by direct alloying or by grain refinement or by the prevention of segregation of particular constituents or inclusions.

(*m*) If possible it should carry elements possessing a high affinity for oxygen or should give rise to an atmosphere which reduces the access of oxygen or other harmful constituents of the welding atmosphere to the metal in order to reduce oxide formation.

(*n*) In arc welding, the flux should contain constituents to assist the maintenance of the arc.

(*o*) After welding or soldering the flux residue should be easily removed, either by brushing or by solution in water.

(*p*) The residue should also be non-hygroscopic and non-corrosive.

(*q*) It should be as economical in use as possible and should not deteriorate in storage.

Reactions Involved

The desired result is the production of a mixture of suitable fluidity, low melting point and low density, containing the maximum quantity of alumina. The double fluorides of aluminium and an alkali metal are understood to take into solution aluminium oxide, cryolite (Na_3AlF_6) being the usual salt employed. Its melting point, however, is almost 1,000 deg. C. and hence it cannot be used alone. The solubility of alumina in molten cryolite a little above this temperature is limited, being placed between 10 and 25 per cent. by different authorities, while the exact reactions have not been fully established.

The usual fluxes all contain an alkali fluoride with other salts, generally chlorides, to lower the melting point, and a sulphate. When an alkali-hydrogen sulphate is present, with an alkali fluoride, the first reaction is usually said to result in the formation of hydrofluoric acid as indicated in the equation:—

$$NaF + NaHSO_4 = Na_2SO_4 + HF.$$

The hydrofluoric acid then apparently reacts with some of the alumina to form aluminium fluoride which in turn combines to give the double fluoride as shown in the equations:—

$$6HF + Al_2O_3 = 2AlF_3 + 3H_2O$$
$$AlF_3 + 3NaF = Na_3AlF_6$$

More aluminium oxide is probably dissolved in the cryolite thus formed.

There are a number of other possible reactions between the alumina or the basis metal and the fluorides and chlorides present; for example, alkali fluorides have been said to react with alumina to give the double fluoride and an alkali aluminate as follows:—

$$4Al_2O_3 + 12\ NaF = 2Na_3AlF_6 + 3Na_2Al_2O_4$$

Nascent fluorine or chlorine may also occur during intermediate reactions and when alkali fluorides are in contact with aluminium at high temperatures reduction may occur as in the following equation:—

$$Al + 3NaF = AlF_3 + 3Na.$$

A small amount of the alkali metal may enter the melt causing modification of metal deposited from silicon-rich filler rods. The remaining alkali metal would of course react first with oxygen or water vapour and might combine to produce an aluminate or a halide.

Hydrochloric acid may also be produced from some of the chlorides present and this may react, at high temperatures, with alumina to give the volatile aluminium chloride as follows:—

$$Al_2O_3 + 6HCl = 2AlCl_3 + 3H_2O.$$

According to H. St. Deville, aluminium chloride and alkali fluoride will react to give cryolite according to the equation:—

$$AlCl_3 + 6NaF = Na_3AlF_6 + 3NaCl.$$

The reaction of alumina and a sulphate is indicated in the equation:—

$$Al_2O_3 + Na_2SO_4 = Na_2Al_2O_4 + SO_3.$$

It appears that the production of aluminium sulphate may be a further fluxing action taking place in stages indicated in the following equations:—

$$2NaHSO_4 = Na_2S_2O_7 + H_2O$$
$$Na_2S_2O_7 = Na_2SO_4 + SO_3$$
$$Al_2O_3 + 3SO_3 = Al_2(SO_4)_3$$

The reaction between the alkali bisulphate and fluorides present takes place continuously, resulting in loss of hydrofluoric acid and it has been proposed that the pyrosulphate should replace the bisulphate, no action taking place below 600 deg. C. in this case.

Although borax and boric oxide are sometimes present in flux mixtures they do not dissolve alumina, but they may be capable of reacting with aluminium fluoride to give an aluminium borate as follows:—

$$2B_2O + Na_2B_4O_7 + 2AlF_3 = 2Al(BO_2)_3 + Na_2O + 2BF_3.$$

The existence of definite aluminium compounds of this type is open to doubt, however, and the melting points of these mixtures are high.

The fluoborates, which are sometimes used, decompose to give an alkali fluoride and borates. The formation of complex alkali-boron compounds with aluminium is possible as indicated in the equation below, but their melting points are high:—

$$3Al_2O_3 + 3B_2O_3.2KF = 3Al_2O_3.B_2O_3 + 6KF$$
$$Al_2O_3 + Na_2O + B_2O_3.2KF = Na_2Al_2B_2O_7 + 2KF.$$

* Extracted from a Report prepared for the Research Council of the Institute of Welding by the R.2. Committee on the Weldability of Non-Ferrous Metals. The investigation has been carried out by the author at the Laboratories of the British Non-Ferrous Metals Research Association, which is co-operating in the investigation.

Slag Control in Steel Furnaces

HOWE MEMORIAL LECTURE

(*Continued from page* 78.)

Colour of Slag.—The colour of the slag when cooled in water is a guide to its approximate composition. Slag colour has one definite advantage, in that a review of any period of the heat may be made if samples have been taken over that period. A melter who is busy tapping "No. 5" may not have had an opportunity to take a look at "No. 1" during its melting period, but a set of slag samples will give him a good idea of the course of events during melting. Slag colour and composition may be grouped roughly as shown in Table III.

Slag Viscosity.—Another useful characteristic is slag viscosity, which has been long used by acid-open-hearth melters as a criterion of slag condition. In this instance the manner in which the slag flows off a stirring rod after withdrawal from the furnace is used as the melter's guide. For basic slags the viscosity is usually determined by the flow of slag in a tube as developed in the work of the Metallurgical Advisory Board in Pittsburgh (Physical Chemistry of Steel Making, 1934). In this method the length of flow actually measures a combination of slag fluidity, the reciprocal of viscosity, and melting

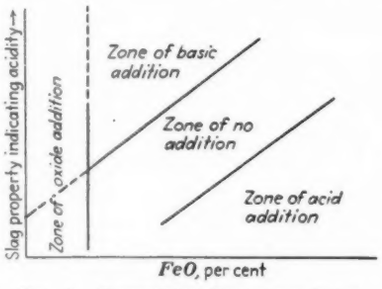
Slag property indicating acidity →
Zone of basic addition
Zone of no addition
Zone of acid addition
Zone of oxide addition
FeO, per cent

FIG. 1.—CORRECTION CHART FOR BASIC OPEN-HEARTH SLAGS.

point. In sampling the slag a test spoonful is cast into the measuring instrument, and the length of flow is measured by a rod inserted in the open end. Care must be taken in casting the slag quickly, for the fluidity of certain types of slag is sensitive to temperature drop.

TABLE III.—*Slag Colour and Composition.*

Colour.	FeO.	CaO/SiO_2 ratio.
Black	Medium	Low
Gray	Low	Low
Light brown ..	Medium	Medium
Dark brown ..	Medium	High
Chocolate brown..	High	High

One objection to this method is that slag temperature will affect the flow, and this is undoubtedly true in extreme cases. The use of fluidity measurements as indicators of slag composition is limited to slags to which no fluorspar has been added.

Other Methods.—In the last few years much thought has been given to new methods of measuring slag composition by quick methods. Among these are magnetic characteristics, density, electrical conductivity measurements, and the use of the petrographic microscope, but none of these has reached the point where it has been put into practice as a control method.

Corrections During Working

The general principle of utilising information obtained during the melting of the heat is simple. For any given grade a certain type of finishing slag is desired. From experience, which, of course, includes correlation of operating and test data, it is known that the more acid a slag during melting, the larger the quantity of lime necessary to arrive at a given basicity. Also, if the early slags are excessively low in iron oxide, the normal build-up of iron oxide in the slag during the refining period may not be sufficient to give a slag of the desired iron-oxide content at the end of the heat, the desired iron-oxide content being controlled by the amount necessary satisfactorily to eliminate phosphorus, accelerate carbon elimination at low carbon contents, or promote the proper action in the moulds of rimmed-steel heats. If the slag is excessively basic during the melting period, large amounts of expensive fluidifying agents may be needed, and the finishing slags may be higher than necessary in iron oxide, thus causing a loss of yield of iron and unnecessarily large additions of deoxidising agents.

With these factors in mind, Fig. 1 shows the procedure that should be followed, based on tests taken during the melting period. This figure shows the iron oxide content in the slag plotted against any slag property that indicates acidity. On the chart are shown four zones, in each of which certain additions are indicated:

(1) If the slag is high in iron oxide and quite basic, the addition of an acid constituent may be indicated, depending on the grade of steel being made. This acid addition will avoid the use of excessive amounts of fluorspar and will assist in keeping the iron oxide content of the slag in the desired range.

(2) In another range of slag acidity and FeO, the heat will finish with the desired slag with no additions. This zone naturally will shift on the chart, depending on the grade of steel.

(3) If the slag is exceedingly acid and reasonably low in iron oxide, a basic addition is indicated, which will give the desired lime-silica ratio at the end of the heat and assist in raising the iron-oxide content of the slag in refining.

(4) If the slag is extremely low in iron oxide it may be necessary to make an addition of oxide to the slag, and usually to make this addition in conjunction with a basic addition.

Obviously, the amounts of these additions will depend on the degree of acidity and on the percentage of FeO in any particular zone. Experience in charting the various slag properties indicating acidity and the percentage iron oxide in the slag allows such charts to be set up, so that by the time the refining period is under way most of the corrective additions will have been made and assimilated in the slag. The advantage of making additions at melt or as soon after as possible is that there is little danger of such additions being undissolved in the slag at the time of tap, and thus reaping the benefits of the additions to the fullest possible extent.

If the heat has been successfully made up to the time the refining period starts, and if the proper steps have been taken to correct the charge and the early slags, the only corrective addition made during refining will be additions of lime to compensate for the silica in the ore added for carbon elimination. However, as a check on the condition of the heat after the slag has begun to shape up, usually tests are taken, which will indicate again the lime-silica ratio of the slag and its iron oxide content. At this time fluidity tests are sometimes of little value because fluorspar may have been added. Slag cakes, slag colour and analyses of slag and metal now serve as the best guides toward slag composition and the necessity for further additions. The disadvantage of slag analysis during this period is that with a fast working heat the analyses may not be returned in time to allow corrective additions to function properly before the heat is ready to be tapped. However, such analyses, together with the taking of slag cakes and colour samples, usually prove valuable in the final adjustment of the slag to its desired composition. The common additions during this period of the heat are burnt lime for increasing basicity and roll scale for increasing the iron oxide content of the slag.

Modifications and Applications

To illustrate modifications and applications of the procedures described, three examples have been chosen of control methods for sulphur, phosphorus and iron oxide in the slag.

Sulphur.—The factors affecting elimination of sulphur have been discussed earlier in the Paper. One of these was the sulphur in the charge. This is an unknown factor at the time the heat is under cover if the furnace gases carry sufficient sulphur to give an appreciable sulphur pick-up by the scrap. Furthermore, at the time of melt it is very difficult to say just how much sulphur will be eliminated from melt to tap. But this much we do know, that the higher the sulphur in the metal at melt, the more work we must do to lower it to a given content. Therefore it seems reasonable to take a sulphur test early in the heat, and make an additional adjustment of the slag as may be indicated. There

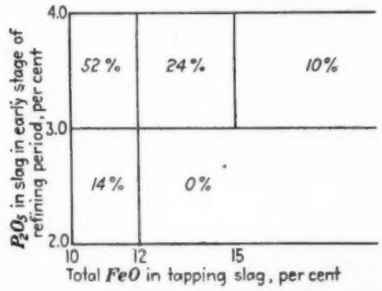

FIG. 2.—RELATION BETWEEN PERCENTAGE OF HIGH-PHOSPHORUS HEATS AND SLAG ANALYSIS.

is no straight-line relationship between the sulphur during the melting period and the sulphur at tap, but the chances of low sulphur at tap are better with low than with high sulphur at melt. Hence we are working in the right direction if we take an early sulphur and add lime as soon as possible if this test shows high sulphur. This can be put on a common-sense basis by knowing the general relationship between the early sulphur and the ladle sulphur and adding lime accordingly. For example, if the sulphur test is taken about an hour before melt, it may very well be that the following relations will be found:

Sulphur 1 hour before melt.	Ladle sulphur to be made.	Extra additions needed.
0·040	0·030	None
0·050	0·030	1 box lime
0·060	0·030	3 boxes lime

This system has been used to good advantage in many plants and is of particular assistance where the diversion of heats for high sulphur, or the working of heats for longer than average time, is excessive.

Phosphorus.—An interesting example of the utility of slag control is found in the records of a plant making a considerable tonnage of carbon steels in the range 0.35 to 0.50 carbon. One of the desired qualities in this particular grade was that the ladle phosphorus should not exceed 0.025 per cent. It has been demon-

(*Continued on page* 94.)

Tinning Copper and Brass by Immersion*

By JOHN D. SULLIVAN and A. E. PAVLISH, Battelle Memorial Institute, Columbus, Ohio

This article deals with an immersion process and a new tin bath that can be used to apply coatings to copper and brass, including intricate shapes, at ordinary room temperature. The coating gives protection to tubing against "green water" and has many other applications, some of which are mentioned later in this Paper.

In the past the application of immersion coating of metals has been quite limited. Some copper-coated iron and steel has been made in this manner, but the production has been of no great importance. Iron and steel articles have been coated with tin by immersion processes that depend on the electrolytic action of the metal being coated. Ordinarily the articles are in contact with metallic zinc which serves to furnish an internal source of electric current.

The compositions of a few typical baths that have been used for the deposition of tin by immersion follow:—

(1) A saturated solution of cream of tartar (potassium acid tartrate) containing 4 to 30 grms. of stannous chloride per litre and operated at boiling temperature.[1]

(2) A bath containing 20 to 30 grms. of ammonium alum and 1 to 2 grms. of anhydrous stannous chloride per litre. The solution must be used at boiling temperature.[2]

(3) An alkaline bath containing 15.0 grms. of stannous chloride, 18.7 grms. of sodium hydroxide, and 7.5 grms. of sodium cyanide per litre, operating at boiling temperature.[3]

Copper and brass are used widely in plumbing, but in many cases trouble is encountered with so-called "green water" resulting from dissolution of copper from pipes, tubes and fixtures. It is reported that trouble results if the content of copper exceeds about 5 parts per million, although colour is detectable at concentrations as low as 2 parts per million. Green stains are accentuated by soaps because of the formation of insoluble coloured copper compounds; so the trouble is particularly noticeable in bathrooms. Often, the trouble disappears when a non-metallic coating, for example, of insoluble calcium salts, forms on the inside of pipes after a few weeks' use. A protective coating to retard temporarily dissolution of the copper until the non-metallic coating is built up is highly desirable. Attempts have been made to overcome the difficulty by coating the inside of pipes and tubes by hot-tinning, but the method is expensive, cumbersome and frequently the coating is not satisfactory in quality. Electroplating the inside of tubes and pipes is impractical because there is no effective way of getting the current into the inside.

Process of Applying Coating

The process comprises applying a tin coating to copper or brass by a simple immersion process.[3] The article is thoroughly cleaned to remove grease and dirt, and preferably pickled, although this step is not essential, immersed in a solution consisting essentially of sodium stannite and sodium cyanide, washed and dried. The better the condition of the metal surface before immersion, the better will be the appearance of the coating. Either hard or soft copper or brass can be coated. The process, likewise, is applicable to copper-coated or brass-coated articles.

An outstanding feature of the process is that coating is effected readily by immersion in a cold bath. The concentration of tin in the bath is high enough so that vigorous stirring is unnecessary, and complex shapes, for example, the inside of coiled tubing, can be coated. This may be done by circulating the solution, but in many cases filling the tube or pipe with solution, letting it stand for the required time, draining and washing is sufficient. This is made possible by virtue of the use of a cold bath. Obviously, tank immersion is practicable, and expensive containers are unnecessary. For example, wood or steel tanks are satisfactory.

A uniform adherent coating is obtained. The thickness depends on the time of immersion. Data are given in Table I for a specific bath containing 50.0 g. per l. NaCN, 5.0 g. per l. $SnCl_2.2H_2O$, and 5.6 g. per l. NaOH.

TABLE I.—*Relationship of Tin Deposited on Copper to Period of Immersion in the Bath. Solution contained 50 g. per l. NaCN, 5.0 g. per l. $SnCl_2.2H_2O$, 5.6 g. per l. NaOH.*

Period of immersion in bath.	Tin deposited.	
	Thickness. In.	Weight. G. per sq. dm.
5 min...	0.000004	0.006
15 min...	0.000006	0.012
30 min...	0.000009	0.017
1 hr.	0.000014	0.026
2 hrs.	0.000021	0.040
24 hrs.	0.00014	0.262

Heating the Coating

If a tin-coated article is heated slightly above the melting point of tin, the latter alloys, at least in part, with the copper. This surface may be given an additional immersion treatment so that there are three distinct layers: Sn, the diffused layer of Cu + Sn, and Cu.

Copper and a wide variety of brasses and bronzes can be treated by the process. It is applicable to the ordinary red and yellow brasses, commercial Cu-Sn alloys, and brasses and bronzes containing low percentages of aluminium and other alloying ingredients. It is not applicable to high nickel-copper alloys such as Monel.

Extensive tests have shown that excellent protection is given to copper and brass tubing against dissolution of copper which leads to "green water" troubles. Tests showed that the most severe attack on uncoated pipe or tubing was caused by distilled water saturated with carbon dioxide, CO_2.

Suitable Bath Concentrations

Tin.—With NaCN constant at 50.0 g. per l. the concentration of tin as sodium stannite was varied from 0.5 to 17.0 g. per l. Good bright deposits were obtained in all cases. This and other work indicated that the concentration of tin in the bath is not critical, but that it must be in the stannous condition. The concentration, however, should be high enough so that too frequent replenishment with sodium stannite or $SnCl_2$ is unnecessary. In most work the authors standardised at about 2.0 to 3.0 g. per l. tin as sodium stannite; *i.e.*, 3.3 to 5.0 g. per l. Na_2SnO_3.

NaCN.—Baths were prepared with the sodium stannite held constant at 4.4 g. per l. and with the sodium cyanide varying from 5 to 150 g. per l. The effectiveness of the coating from the various baths was determined by immersing cleaned copper specimens in the baths for 5, 10, 30 and 60 mins., and testing the tin coating produced. The coated specimens were examined for appearance and completeness of tin coating, and they were also subjected to a hydrogen sulphide corrosion test, which comprised exposing the tin-coated specimens for one hour in a covered desiccator saturated with water vapour and containing hydrogen sulphide.

It is obvious, of course, that the hydrogen sulphide test is a severe one, and that for many purposes the appearance test is sufficient. The data show, however, that high cyanide concentrations are desirable, and that by employing them, the time required to obtain a satisfactory coating is noticeably decreased. For best all-round service the concentration preferably should exceed 25 g. per l. NaCN, and 50 g. per l. is recommended.

Stability of Baths

No particular attention is required to keep the bath in working order. Periodic titrations should be made to ensure that the NaCN and stannous tin concentrations are high enough. Stannous tin is slowly oxidised in stannite-cyanide solutions to the stannic condition, and in this form it will not coat, but fairly high concentrations of stannic tin can be tolerated with no ill effect, provided the bath contains stannous tin. Addition of as much as 200 g. per l. $Na_2SnO_3.3H_2O$ did no apparent damage. As the stannous tin is depleted the bath can be replenished by adding a stannous salt, for example, sodium stannite or stannous chloride.

Sodium cyanide, likewise, decomposes in baths to form carbonate and some cyanogen. This rate, however, is no greater than in cyanide electroplating solutions. A bath containing 51.0 g. per l. NaCN after standing open in the air for 16 days had decreased only to 48.7 g. per l., and one with 25.0 decreased only to 23.5.

Copper dissolved from the copper or brass will not cause trouble in normal operations. Addition of as much as 50 g. per l. of either $CuSO_4.5H_2O$ or Cu_2Cl_2 had no ill effect on a bath.

The sodium stannite-sodium cyanide is easily prepared. Sodium stannite is produced by the reaction of a stannous salt, for example, stannous chloride, with sodium hydroxide according to this equation:—

$$SnCl_2 + 4\ NaOH \rightarrow Na_2SnO_2 + NaCl + 2\ H_2O$$

Sodium hydroxide is added slowly and with agitation to an aqueous solution of stannous chloride. After adding the sodium cyanide and diluting to the required volume, the bath is ready for use.

Applications

Applications were mentioned previously and specific data given on protecting plumbing from "green water" formation. The process, however, has wide application and can find use in any place where a relatively thin coating of tin on copper or brass is required. Only a few possible uses will be mentioned. It would appear that the protection is adequate for tinning copper wire to be used with the rubber type of insulation. The tin not only adds resistance to corrosion, but also gives a coating conducive to soldering.

Novelty articles, fixtures, etc., can be given satisfactory coatings. One of the authors used an ash tray coated in this manner for over two years, and at the end of that time the finish was still satisfactory. The tray was easily cleaned.

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* Extracted from "Metals and Alloys."

The Fatigue and Impact Strengths of Cast Iron

By J. W. DONALDSON, D.Sc.

In THE FOUNDRY TRADE JOURNAL[1] of 1936, the author reviewed the work which had been carried out on the fatigue and impact strengths of cast iron. Various researches dealing with the fatigue properties of high-duty cast irons, the effect of surface finish, the influence of graphite and of the notch effect, the fatigue resistance of alloy cast irons, the effect of speed of reversal, low temperatures and combined cyclic stresses on the fatigue properties were considered. Since then further work has been carried out on the endurance properties of cast iron. Results have been obtained for recently-developed high-duty and alloy cast irons, the effect of overstressing and understressing cast iron has been more fully investigated and more data have been obtained for the behaviour of high-duty and alloy cast irons under combined stresses.

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TABLE I.—*Composition and Strength of Cast Irons.* (*Pomp and Hempel.*)

No.	Composition.					Tensile strength. Tons per sq. in.	Compressive strength. Tons per sq. in.	Brinell hardness.
	C	Si	Mn	S	P			
1	3.04	1.92	0.64	0.076	0.53	11.0	46.0	197
2	3.09	2.07	0.69	0.15	0.15	15.0	59.0	202

With regard to impact strength, various forms of impact tests were considered in the previous review and their applicability to cast iron dealt with, special consideration being given to the systematic investigation on impact testing carried out by Sub-Committee A-3 on Cast Iron of the American Society for Testing Materials, an investigation in which twenty-five cast irons, having a wide range of composition and prepared by various melting methods, were submitted to thirteen types of impact tests. Developments which have taken place in the last four years have been the development of suitable impact tests for cast iron, investigation by such testing methods of the impact strength of high-duty and alloy cast irons, and investigations on impact strength and notch-sensitivity of cast iron.

TABLE II.—*Fatigue Tests on Cast Crankshafts.* (*West.*)

Specimen.	No. of reversals. Millions.	Fatigue stress. Tons per sq. in.
B	4.91	7.0
	0.22	8.0 (Failed)
C	9.445	7.0
	4.74	7.5
	10.82	8.0
	10.084	8.25
	7.102	8.5
	1.091	9.0 (Failed)
D	10.025	7.25
	5.006	7.75
	1.46	8.25 (Failed)
E	10.01	7.5
	5.004	8.0
	0.648	8.25 (Failed)
F	0.343	7.75 (Failed)

Such recent investigations are of considerable interest not only to designers and engineers, who have to deal with those newly-developed alloys for use in highly-stressed moving parts, but also to foundrymen and metallurgists who are responsible for the production of such alloys.

Fatigue Strength of Grey Cast Irons

The fatigue strength of two cast irons whose composition, tensile and compressive strengths, and Brinell hardnesses, are given in Table I, were investigated by Pomp and Hempel.[2] The tests were made on a two-million cycle basis in a 60-ton machine operated by fluctuating fluid pressure and designed so that alternating tensile and compressive stresses of different mean values were applied at the rate of 500 alternations per minute. Test pieces 22 mm. in diameter were used, and the stresses obtained were calculated on the original cross-sectional area, as using the actual area decreased the stress range values slightly without altering the general shape of the endurance curve obtained.

Endurance stress diagrams were obtained from the test data and these showed that for both irons the fatigue range increased steadily with compressive mean stress, even past the point of zero minimum stress, until the maximum stress almost reached the static compressive strength. The results also showed the relationship between the intrinsic fatigue strength and the tensile or compressive stress, and between the tensile-compression endurance strength and the tensile strength. The ratio of the repeated stress fatigue range in compression to that in tension was 3.4 for the first iron and 3.3 for the second iron, while the ratio of the static compression strength to the static tensile strength was 4.2 and 3.8 respectively.

The ratio of the tension-compression reversed stress range to the tensile strength was 0.23 and 0.25 for each iron, as compared to 0.33 and 0.60 for the ratio of reversed bending fatigue stress to tensile stress. With high compressive mean stresses, the structure of the surfaces of both irons was partially destroyed. The notch effect of graphite was also found to be less important with compressive stresses than with tensile stresses.

Fatigue of Cast Crankshafts

Fatigue tests on cast materials for crankshafts have been carried out by West,[9] and included with other tests on such materials in the First Report of the Research Committee on High-Duty Cast Irons for General Engineering of the Institution of Mechanical Engineers. As a result of preliminary tests on molybdenum and chrome-molybdenum cast irons, several crankshafts having a composition of T.C 3.0, Si 1.8, Mn 1.0, S 0.05, P 0.20, Cr 0.21 and Mo 0.78 per cent. were cast and built into petrol-driven service engines. To determine the fatigue resistance of this material, test-pieces were cut from the centre of each web of a crankshaft. These specimens were approximately 5.5 in. long, 0.7 in. dia., and were machined to the standard Wohler test-piece. Before carrying out fatigue tests, Young's modulus of the five specimens tested was determined, and gave an average value of 17.7×10^{-6} lbs. per sq. in. The fatigue values obtained are given in Table II, and show the limiting fatigue stress to be between 7.75 and 8.25 tons per sq. in. These values give an average endurance ratio of 0.30.

In discussing the results obtained, it is stated that in comparing similar materials having the same Young's modulus, the usual limiting fatigue stresses may be employed as the basis of comparison, but in the case of cast iron, where varying values of Young's modulus are obtained, it may be better to base such comparisons on the limiting fatigue distortions, and this may be done by measuring both the limiting fatigue stress and Young's modulus and assessing the merits of the two materials by the ratio of these two properties. For the cast iron tested, the limiting fatigue stress was approximately 7 tons per sq. in., and Young's modulus 17.7×10^{-6} lbs. per sq. in. Comparing this material with a typical steel with a limiting fatigue stress of 20 tons per sq. in., and a Young's modulus of 30×10^{-6} lbs. per sq. in., the ratio of limiting fatigue distortion of steel to that of cast iron is 1.68, while the ratio of limiting fatigue stress is 2.86. The first comparison shows the cast iron in a much more favourable light than is given by the second comparison, which is of importance in crankshafts where strain which arises largely from torsional oscillations or from overstressing due to a high mean effective pressure in relation to the rigidity of the design, is a function of the amount of distortion of the shaft rather than of the application of a definite bending moment.

In an attempt to develop an alloy iron of high strength for cast crankshafts for heavy-oil engines, an iron containing T.C 1.74, Si 0.62, Mn 0.63, S 0.05, P 0.05, Ni 1.94 and Mo 0.64 per cent. was experimentally examined. Test-pieces were first given a preliminary heat-treatment by cooling from 1,000 to 900 deg. C. over a period of 24 hrs. They were then reheated to 900 deg. C. for 1 hr., transferred to a furnace at 650 deg. C., and held for 1 hr. before cooling in air. After reheating and cooling in air, the test-pieces were subjected to various tempering temperatures ranging from 550 to 700 deg. C. The average value of Young's modulus for this material was 21.5×10^{-6} lbs. per sq. in., and fatigue tests showed the endurance limit to be about 12 tons per sq. in. This value is a considerable improvement on the untreated iron used for petrol engines, being 70 per cent. better, but the endurance ratio of this material was between 0.19 and 0.26 on account of its higher ultimate stress, values which are below the figure of 0.30 obtained for the untreated iron.

Fatigue of Copper Cast Irons

In an extensive investigation on the use of copper in cast iron, conducted recently at the Battelle Memorial Institute by Lorig and Schnee,[4] determinations were made on the endurance properties of six cast irons containing approximately T.C 3.15 and Si 1.5, five of which contained copper varying from 0.5 to 3 per cent. Fatigue tests were made with a standard Moore high-speed fatigue testing machine operating at approximately 10,000 revs. per minute. Test specimens were of the standard type for this machine, being 3.7/16 in. long, 0.270 in. in smallest section and having a contour swept with a 4.993 in. radius, and were machined from 1.2-in. diameter test-bars. Endurance tests were made by testing six speci-

mens from each of the six cast irons at various loads and obtaining for each an S.N. (Stress: Number of Cycles) curve. From these curves the endurance limit for each iron was determined and from this and the tensile strength the endurance ratio was calculated. In Table III are given the endurance limits of the various irons together with their compositions, tensile strength, and endurance ratio.

These results show the endurance ratio to fall from 0.47 in the unalloyed iron to 0.41 in the iron containing 3.1 per cent. copper and indicate the influence which a small addition of copper has on the fatigue property of cast iron. This falling off in fatigue strength with alloy additions is typical of high-strength alloy cast irons.

Table III.—*Endurance Limits and Endurance Ratios of Copper Cast Irons.* (*Lorig and Schnee.*)

No.	Composition.			Tensile strength. (A). Tons per sq. in.	Endurance limit. (B) Tons per sq. in.	Endurance ratio. B/A.
	C	Si	Cu			
30	3.16	1.54	0	21.6	10.3	0.47
31	3.20	1.50	0.53	21.2	8.5	0.40
32	3.18	1.59	0.99	22.3	9.8	0.44
33	3.15	1.58	1.45	23.7	10.7	0.45
34	3.18	1.49	1.98	24.3	10.7	0.44
35	3.16	1.44	3.10	25.0	10.3	0.41

Effect of Overstressing and Understressing

In an investigation on the effect of overstressing and understressing in fatigue by Kommer,[5] carried out on various steels, results are included for a cast iron. In this investigation fatigue curves were determined after the application of various numbers of cycles, 10, 20, and 30 per cent. overstress, and the effects of overstress on the fatigue properties and the changes taking place in an ordinary fatigue test to failure discussed. The effects of progressively increasing understress on the specimens which did not fail in overstress are dealt with, and the effects of overstressing and understressing on the static properties as determined subsequent to the fatigue test are considered. Tests were also carried out on standard smooth specimens and on square notch specimens.

The tests were carried out on a fatigue testing machine, running at 1,750 r.p.m., which subjected a rotating beam specimen to completely reversed bending stress. Standard test specimens (after notching) were 0.330 in. diameter for the cast iron and were turned, ground and polished. The notched specimens were of 0.5-in. diameter bar, having a circular square notch which reduced the diameter to 0.330 in. The cast iron tested contained T.C 3.57, Si 1.58, Mn 0.58, S 0.06, and P 0.66 per cent. and had a tensile strength of 15 tons per sq. in. The endurance limit on the standard test-bar was 9.85 tons per sq. in., which gave an endurance ratio of 0.66, and the endurance limit on the notched specimen was 7.0 tons per sq. in.

In testing, a series of specimens were subjected to a definite cycle ratio at a definite percentage of overstress, the cycle ratio being the ratio of the number of cycles the specimen is subjected to to the number of cycles at which it will fail at a definite overstress. When the specimen had been subjected to the number of cycles corresponding to the cycle ratio, the load on the specimen was reduced in order to determine the value of the new endurance limit in relation to the original endurance limit, and the amount by which the former was below the latter was considered the percentage of damage, and by choosing a series of cycle ratios, data were obtained for plotting a damage curve at a definite percentage of overstress.

Damage curves were thus obtained for 10, 20, and 30 per cent. overstress. By carrying out these tests the fatigue test was broken up into stages, and by determining the new endurance limits and different cycle ratios, it was possible to determine what the fatigue process was doing in changing the fatigue properties of the material before failure.

In Table IV is given a comparison of the damage results obtained for the cast iron, showing the approximate percentage of damage due to 10, 20 and 30 per cent. overstress at cycle ratios of 20, 50 and 80 per cent. for both standard and square notched specimens. Plus signs indicate endurance limits increased and minus signs endurance limits decreased. For this iron the number of cycles for failure at 10, 20 and 30 per cent. overstress occurred at 520,000, 160,000 and 60,000 cycles or reversals respectively. The results obtained for the cast iron were unique when compared with those obtained for the steels in that all the values for the square notched specimens were above the line for zero damage, which indicated that for this particular iron square notched specimens were not damaged by overstress even when the cycle ratio was 80 per cent.

All specimens which did not fail in overstressing were subjected to progressively increasing understress in periods consisting of approximately 2,500,000 cycles. These tests showed that the damage, which had been done by overstress, could be repaired by progressively increasing understress as the endurance limit, which had been decreased by overstress, was sometimes not only restored to its original value, but at other times increased to the value of the original overstress and sometimes even over the original overstress by substantial percentages. Understressing tests following overstressing showed that the damage done by overstressing was not always permanent, and also suggested that the endurance limit of a material is not a fixed quantity, but one which can be altered by various stressing operations.

Table IV.—*Damage Due to Overstress of Cast Iron.* (*Kommers.*)

Per cent. overstress.	Standard specimen.			Square notched specimen.		
	20 per cent. cycle ratio.	50 per cent. cycle ratio.	80 per cent. cycle ratio.	20 per cent. cycle ratio.	50 per cent. cycle ratio.	80 per cent. cycle ratio.
10	−1	−2	−3	+5	+4	+3
20	−8	−8	−9	+1	0	−1
30	−11	−14	−18	+5	+4	+3

Table V.—*Composition of Alloy Cast Irons and Alloy Steel.* (*Gough and Pollard.*)

Description.	Condition.	Composition.								
		C	Si	Mn	S	P	Ni	Cr	Mo	Cu
Copper-chromium iron	Heat-treated	1.56	1.16	0.44	0.049	0.067	Trace	0.46	—	1.75
Inoculated iron ..	As cast ..	2.75	1.59	0.88	0.073	0.076	—	—	0.29	—
Chrome-molybdenum iron	As cast ..	3.28	2.19	0.95	0.095	0.17	—	0.42	0.95	—
Nickel-chromium iron	As cast ..	3.36	1.22	0.92	0.113	0.124	1.87	0.47	—	—
Alloy steel	Heat-treated	0.32	0.23	0.88	0.04	0.03	2.42	0.49	0.38	0.13

Combined Fatigue Stresses

In an investigation carried out by Gough and Pollard[6] on behalf of a co-operative research committee, consisting of representatives of the Institute of Automobile Engineers, the British Cast Iron Research Association, and various firms interested in cast crankshafts, resistance to combined fatigue stresses was determined on a series of cast irons and an alloy steel. The four cast irons tested included a copper-chromium iron extensively used in the production of high-duty cast crankshafts; an inoculated iron developed for similar purposes; a chrome-molybdenum iron used for many engineering parts, including crankshafts; and a nickel-chromium iron developed as a low-duty crankshaft material and used for small oil- and petrol-engine crankshafts. The compositions of these irons, together with that of the alloy steel tested, are given in Table V.

The resistance of these materials to combined fatigue stresses was determined in a very extensive series of tests carried out in a specially-designed machine, operating at a speed of 1,500 stress cycles per min. The fatigue value of each iron was first determined on a 10^{-7} cycle basis by the usual method of determining endurance limits, then fatigue limits were determined for each iron under reversed plane bending stress, reversed shearing stress, and five combinations of these stresses in which the range of bending stress to range of shearing stress had values of 0.268, 0.577, 1.000, 1.732 and 3.732. The essential results from these tests are summarised in Table VI.

In Table VI, a comparison is also made of the fatigue resistances of the four cast irons with the alloy steel tested with regard to their tensile strengths and endurance ratios. Those results show that, although the tensile strengths of the alloys vary by as much as 64 per cent., the endurance ratios for bending of all the materials show no marked variations, having a maximum difference of 11 per cent. only. The endurance ratios for torsional stressing have a much greater variation, due to the relatively low value obtained for the alloy steel. In general, the fatigue resistance of all the materials is high in relation to their tensile strength.

In dealing with fatigue, it is also of interest to note that the failure of metals by fatigue has been investigated by Gough and Wood[7] by applying precise methods of X-ray diffraction to a systematic study of the changes produced in the crystal structure under various conditions of stress. Cast iron was not tested, but interesting data were obtained with alternating torsional fatigue tests on a 0.12 per cent. carbon steel. The application of cycles of a safe range of stress was found to be unable to cause progressive damage to the state of structure, as a stable state has been established. If the range of stress exceeded the fatigue range, the total

damage caused was dependent on the amount by which the applied range was in excess of the safe range, but the characteristic nature of the changes which occurred in the neighbourhood of fatigue cracks was exactly similar under all unsafe ranges of stress. Changes of structure were found not to occur at once, but to represent the summation of progressive changes which took place during the cyclic history of the specimen.

Impact Testing

Investigators of the impact strength of cast iron have all stressed the necessity of a standardisation of a suitable and simple impact test which would give information of the characteristics of the material not obtained by other means. During recent years, the British Cast Iron Research Association has adopted the Krupp-Stanton repeated impact test for the impact testing of cast iron.[8] It has been shown that this test can be made to approach either a single blow test on the one hand or a fatigue test on the other by varying the weight and height of fall of the weight, and the test used by the Cast Iron Research Association is adapted to co-ordinate both these extremes. It consists essentially of a hammer or weight dropping from a given height and operated by means of a cam so as to deliver a striking blow of 0.48 ft.-lb. on a cylindrical test-piece 15 mm. dia., having a shallow round notch instead of the square notch used in the original Stanton test for steel. This test, although it gives fairly satisfactory results for the impact resistance of cast iron, is not very suitable for routine work, since the specimen is not simple to prepare and the time taken to determine the impact strength of some irons is considerable. A single blow test has therefore been developed by the Association using the standard Izod machine with a special vice and a 0.798-in. dia. unnotched test-bar.

The results obtained by these two tests on a number of high-duty and alloy cast irons have been published in the Report of the Research Committee on High Duty Cast Irons,[3] already referred to. In this Report the mechanical tests on 21 commercial irons manufactured for various purposes by various methods are reviewed. In Table VII are given the results of the impact test made on certain of the irons, together with their compositions, tensile and transverse strengths.

The values obtained for the repeated blow tests show that there is a wide range in such tests, extending from 650 for a good cylinder iron to over 100,000 for a high-strength alloy cast iron, and that more uniform results for all the irons are obtained from the single blow test. There is little direct relationship between the impact strength and the tensile strength, as a pearlitic iron with a good tensile strength has a low impact value, and an austenitic iron with a low tensile strength a much higher value. It has been suggested that the impact strength of cast iron depends on its ability to deform plasticly under load, and as the plastic property is constant at about 25 per cent. of the total deformation at fracture, the impact value of cast iron will increase with the strength, provided the plastic value does not vary from normal. In austenitic cast irons, where the plastic value is high, a high resistance to impact is obtained, and in high-strength cast irons of poor plastic properties low impact value results.

Impact Strength and Notch Sensitivity

An extended investigation of the impact resistance of cast iron and its sensitivity to notch effects has been made by Piwowarsky.[9] A series of 26 cast irons varying in composition and method of manufacture was tested using some 8,000 test specimens. The tests were carried out under a wide variety of conditions, which included the form of the test-piece, the form of the notch, method of support, rate of blow, the effect of carbon and phosphorus content, the addition of nickel and chromium, and the absence or presence of casting skin.

In general, the results of the tests showed that the impact strength of cast iron is related to the type of test-bar selected and the distances between the supports, and that a test-bar having a cross-section of less than 1 sq. cm. is not suitable for determining the impact strength of bars in the as-cast condition. The speed of the blow has a considerable influence on the values obtained, while the absence or presence of casting skin, particularly in the annealed condition, has no appreciable influence on the impact strength. Comparative values can therefore only be obtained by a precise knowledge of the shape of the test-bar, distance between the supports, and rate of impact of blow.

Low carbon content combined with a suitable heat-treatment is the best means for obtaining a cast iron of high impact strength, and the addition of 1.7 per cent. nickel and 0.5 per cent. chromium further increases the values obtained. The notch sensitivity increases with the general quality of the irons, and it is possible to obtain

(*Continued on page* 96.)

Table VI.—*Summary of Static, Impact, Hardness, and Fatigue Tests on High-Duty and Alloy Cast Irons.* (*Gough and Pollard.*)

Material.			Alloy steel.	Cu-Cr iron.	Inoculated iron.	Cr-Mo iron.	Ni-Cr iron.
Tensile limit of proportionality, tons per sq. in.			31.5	15.5	2.5	2.5	2.2
Ultimate tensile strength, tons per sq. in.			52.3	32.3	23.3	20.8	18.8
Modulus of elasticity, lbs. per sq. in. $\times 10^{-6}$			29.3	26.8	21.7	20.1	18.7
Brinell hardness			260	260	245	280	265
Torsional limit of proportionality, tons per sq. in.			17.3	15.6	4.3	2.7	2.7
Torsional modulus of rupture, tons per sq. in.			46.5	38.6	31.9	32.7	21.1
Total twist at fracture, (L/D = 8½), degrees			846	96	82	53	16
Modulus of rigidity, lbs. per sq. in. $\times 10^{-6}$			11.5	11.4	8.6	8.6	7.1
Izod, notch bar, ft.-lbs.			24.8	1.2	1.5	0.8	0.4
Wohler fatigue limit, tons per sq. in.			±22.3	±12 to ±19	±12.9	± 9.4	± 8.9
Alternating torsional fatigue limit, tons per sq. in.			±14 to ±12.3	±14.7 to ±13.9	± 9.7	± 8.4	± 7.1
Fatigue resistance as determined using combined stress machine.	Cycles of reversed bending stresses.	Fatigue limit, tons per sq.in.	±26.6	±18.2	±12.9	±10.8	±10.6
		Endurance ratio	0.509	0.564	0.554	0.519	0.564
	Cycles of reversed shearing stresses	Fatigue limit tons per sq.in.	±17.9	±14.4	±11.4	±10.9	± 8.9
		Endurance ratio	0.342	0.446	0.489	0.524	0.473

Table VII.—*Composition and Properties of High-Duty Cast Irons.* (*Research Committee of Institution of Mechanical Engineers.*)

Type of iron.	Composition.									Ultimate breaking stress. Tons per sq. in.	Transverse rupture stress. Tons per sq. in.	Deflection on 18-in. span. In.	Elastic modulus. Lbs. per sq. in. $\times 10^{-6}$	Brinell hardness.	Single impact test. Ft.-lbs.	Repeated impact test. No. of blows to fracture.
	T.C	Si	Mn	S	P	N	Cr	Cu	Mo							
Ordinary ..	3.06	1.32	0.57	0.133	0.76	—	Trace	—	—	18.0	28.6	0.19	18.9	241	8.5	647
Low carbon ..	2.65	2.39	1.49	0.079	0.23	—	0.07	0.06	—	17.9	34.3	0.13	20.6	259	8.3	655
Emmel ..	2.72	2.26	1.13	0.094	0.28	—	0.14	2.12	—	20.4	31.8	0.11	—	290	6.4	2,500
Alloy	3.20	1.26	0.89	0.125	0.46	1.52	0.36	—	—	18.1	34.7	0.17	18.1	234	11.9	5,930
Ni-Tensyl ..	2.89	1.51	1.23	0.084	0.08	1.75	Trace	Trace	—	23.2	41.3	0.26	19.3	268	17.5	24,000
Low alloy ..	3.18	2.06	0.92	0.103	0.17	—	0.21	0.21	—	19.4	31.6	0.13	18.6	241	9.2	2,248
Inoculated ..	2.96	1.08	1.04	0.037	0.048	1.48	Trace	Trace	—	19.0	39.6	0.30	17.5	230	14.1	5,611
Alloy	3.00	1.62	0.82	0.09	0.17	—	0.06	Trace	0.63	23.0	36.8	0.26	19.6	242	13.2	3,980
Alloy	2.79	1.24	0.79	0.034	0.03	1.65	—	—	0.39	24.2	35.3	0.25	17.5	293	13.7	150,929
Heat and corrosion resist.	1.14	1.78	0.47	0.034	0.01	0.22	33.83	2.01	—	28.0	32.3	0.11	33.2	331	13.1	152,000

Table VIII.—*Impact Tests on High-Duty Cast Iron.* (*Piwowarsky.*)

Composition.					Treatment.	Single blow test.	Ring test.
C	Si	Mn	S	P			
2.6	2.52	0.43	0.025	0.191	850 deg.—oil	0.18	7.5
					850 deg.—oil, 450 deg.—lead	0.24	13.0
					850 deg.—oil, 650 deg.—air	0.45	383.5
2.48	2.94	0.74	0.026	0.15	850 deg.—oil	0.24	13.0
					850 deg.—oil, 450 deg.—lead	0.41	244.0
					850 deg.—oil, 650 deg.—air	0.68	997.5

Lighting in Factories

COMMITTEE'S RECOMMENDATIONS

The Ministry of Labour and National Service has just issued the Fifth Report of the Departmental Committee on Lighting in Factories,* which states that, generally speaking, two features characterise industrial work in a large number of factories at the present time. In the first place, the work has to be done at high pressure, and much greater strain is imposed on the worker. Secondly, owing to the prevalence of night work and overtime, the time spent under artificial light is far longer, even in factories which provide adequate natural light. In pre-war days, for example, a working day of 8 a.m. to 5.30 p.m. connoted the use of artificial light for about 10 to 15 per cent. of the yearly hours of employment; at present, it is often 50 to 100 per cent.

The Committee have been unable to find any evidence that prolonged or even continuous work under artificial light has any deleterious effects upon health or safety, though it may be that at a later stage such effects may be established. It is obvious, however, that the present conditions of work in many factories (especially in factories completely obscured) are unnatural and new to the majority of workers. The Committee are accordingly agreed that exposure to such conditions justifies the maintenance of a higher standard of lighting than that previously recommended by them, in the interests both of the workers and of increased production. Some of the important recommendations are appended.

With regard to the adequacy of artificial lighting in respect of interior work places, the Committee recommend that:—Over the interior parts in which persons are regularly employed the illumination shall be not less than 6 foot-candles without prejudice to any additional illumination required by the nature of the work. Provided that in parts of factories where persons are employed, in which the mounting height of the light sources necessarily exceeds 25 ft. measured from the floor, or where the structure of the room prevents the uniform provision of this standard, the illumination shall not be less than 2 foot-candles, and not less than 6 foot-candles where actual work is being done, without prejudice to any additional illumination required by the nature of the work. The illumination shall be measured in the horizontal plane at a level of 3 ft. from the floor.

In respect of interior passage and access, the Committee see no reason to alter the standard previously suggested.

Concerning the reflection factor of surroundings, the Committee recommend that: Throughout the interior parts, in which persons are regularly employed, walls, partitions, ceilings, tops of rooms, including interior surfaces of windows and rooflights through which the passage of daylight is continuously prevented, and as far as practicable other structural fixtures, which are less than 20 ft. above floor level, shall be maintained light in colour.

The Committee's recommendations with regard to the suppression of glare are:—(1) Where any light source in a factory is less than 16 ft. in height above floor level, no part of the source or fitting having a brightness greater than 10 candles per sq. in. shall be visible to any person whilst normally employed within 100 ft. of the source, unless the angle of elevation from the eye to the source exceeds 20 deg.

(2) All local light sources in a factory shall be provided with suitable shades of opaque material or other effective means by which they shall be completely screened from the eyes of every person employed at a normal working place.

(3) Adequate means shall be provided as far as reasonably practicable by suitable screening or placing or other effective method to prevent discomfort or injury by the reflection of light from smooth or polished surfaces into the eyes of the worker.

Concerning the avoidance of shadows, it is recommended that adequate means shall be taken, as far as reasonably practicable, to prevent formation of shadows which interfere with the safety of, or cause discomfort to, any person employed.

The following valuable appendices are included in the Report:—(1) Values of illumination recommended for various tasks; (2) Tables and notes indicating approximate lamp sizes in appropriate fittings necessary at various mounting heights and spacings (*a*) using tungsten-filament lamps for 6 foot-candles, (*b*) using gaseous discharge lamps, (*c*) using tungsten-filament lamps for 2 foot-candles, and (*d*) using gaseous discharge lamps; (3) Illumination of approximately 0.5 foot-candles in corridors and staircases.

* H.M. Stationery Office, York House, Kingsway, London, W.C.2. (Price 3d. net.)

Slag Control in Steel Furnaces

(*Continued from page* 89.)

strated that the controlling factors in phosphorus content of the finished steel are basicity, iron oxide content, P_2O_5 content of the slag, and temperature. Lacking complete slag analyses, the basicity may be roughly judged by the FeO content of the slag, the latter generally decreasing with decreasing basicity.

This grade of steel was made over an extended period with no definite slag-control schedule, and 22 per cent. of the heats finished higher in phosphorus than specified to the open hearth. A survey of these heats showed an interesting relationship between the P_2O_5 of a preliminary slag and FeO content of the tap slag (Fig. 2). In this figure the percentage of high-phosphorus heats is shown in the various analysis zones.

On the basis of these data the phosphorus content of the iron was lowered slightly and a slag-control schedule was put into effect, which gave the melter the P_2O_5 and FeO contents of the slag shortly after melt, with suggested additions for increasing the FeO and CaO content, depending on the analyses. A two-months' run on these schedules resulted in only 3 per cent. of the heats above the limit specified to the open hearth. The percentage of heats with more than 3.0 per cent. P_2O_5 decreased from 77 to 30, and the percentage of high-phosphorus heats in the upper brackets decreased from 27 to 9, in the lower brackets from 3 to 1. Had the iron been changed with no slag-control schedule, the percentage of high-phosphorus heats would have been 9.5. With the same iron and slag control the percentage would have been 7.1; with both operating simultaneously the percentage was 3.0.

The optimum cost to the plant in this case can easily be calculated by correlating the decreased value of the high-phosphorus heats, the cost of the two types of pig-iron and the costs of the extra additions made necessary by the slag-control schedules.

Iron Oxide in Slag.—In controlling the FeO content of the slag it is generally advisable, in making killed steels, to carry as low an FeO as is consistent with reasonable elimination of phosphorus. High oxide contents result in loss of iron in the slag.

Sheet and Strip

Sheffield City Libraries, Sheffield, 1, have now issued Research Bulletin No. 4, "Sheet and Strip," Part II. The contents cover references to finishing processes and special strip material, including vitreous enamelling. This bulletin, as well as those previously published, is obtainable on sending threepence postage to the City Librarian.

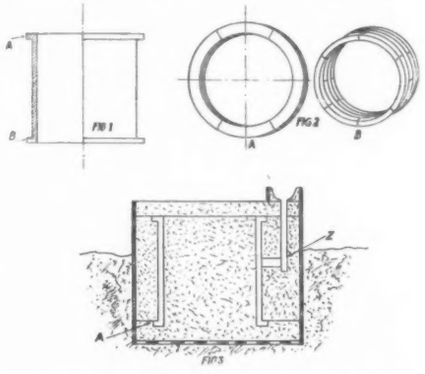
Some Jobbing Foundry Experiences—III

By "TRAMP"

The manufacture of the casting illustrated in Fig. 1 should present no difficulty to those foundries which are equipped with adequate lifting facilities and which are called upon to produce large numbers of castings from the same design. In these cases a strong standard pattern is made and jointed for moulding in a three-part box, the centre core being either made in a full core box or swept up in loam. The main dimensions of the example illustrated are: Diameter of the flange A and B, 3 ft.; diameter of the body, 2 ft. 8 in.; bore, 2 ft. 6 in.

Jobbing foundries have to adopt different methods, and make the job in green sand with the minimum of patternwork. The patternwork required for this method consists of two flanges as A, Fig. 2, and a ring as shown at B; this ring need only be about 6 in. deep, although the overall length of the casting is 2 ft. or more, and the same size as the barrel inside and out. As jobbing shops are often limited for head room, the job is moulded and cast in a pit in the foundry floor. The first operation is to lay a bottom box in the floor down a suitable depth to facilitate easy access to the runner bush for pouring (Fig. 3).

This box is levelled in position and flange A (Fig. 3) bedded in, a joint being made from



the outside of the flange to the edge of the box. A middle-part moulding box is then lowered in place and ring B (Fig. 2) placed over the flange. Ramming is then carried on inside and out and the pattern "drawn through" a sufficient number of times until the correct height is reached, when the other flange is placed around the ring pattern and a top box used to finish off the mould. The top box being removed, the flange and ring pattern are withdrawn and the middle box is lifted clear of the inside mould and placed over a brazier on the foundry floor to skin-dry. The bottom flange is extracted by lifting up over the central portion. The whole is again assembled and secured for casting. As the sand used is very tough, no staging or liftering is required in either the mould or core and satisfactory castings are produced.

Another important difference from the procedure in specialised shops is the pouring temperature for these castings. A well-made dry-sand or loam mould and core can withstand practically as hot an iron as can be obtained, but the jobbing foundry has to use much colder iron to get good results. Consequently, runners must be of much larger proportions than are necessary if hot iron were being poured. These particular jobs are run half-way down the barrel Z (Fig. 3), a draw ingate and downstick being rammed up in the job. These are removed after the mid-portion of the mould has been lifted.

For High Quality Castings

The increasing demand for high-strength close-grained iron castings calls for improved metal. In comparison with the accepted standards of the past, the modern high quality casting requires lower total carbon and phosphorus, with a closer range in silicon. The Ironfounder can now meet this demand at a reasonable cost by the use of Stanton-Dale Refined Pig Iron.

Stanton-Dale is a pig iron of low total carbon, the graphitic carbon being uniformly distributed and of fine curly-flake formation. The close structure ensures remarkably high strength with good machineability, and Tensiles of 16 to 20 tons can readily be obtained when a proportion of Stanton-Dale Iron is introduced.

The use of this iron avoids the irregularities in structure which are sometimes observed when steel scrap has formed part of the charge.

The correct grade of Stanton-Dale Iron to use depends on the type and class of castings to be made. The Stanton Technical Service is available to advise on suitable mixtures.

Total Carbon from 2.6 per cent. upwards. *Analysis to individual specification as required.*

STANTON-DALE
REFINED PIG IRON

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

Iron and Steel Scrap Position

MR. HERBERT MORRISON'S STATEMENT

A statement by Mr. Herbert Morrison, the Minister of Supply, on the position of iron and steel scrap is reported at length below:—

"I am satisfied," said Mr. Morrison, "that the steelworks are to-day receiving all their requirements of home-collected iron and steel scrap, and I am determined to ensure the continuance of this state of affairs, even if the demand of the works increases and conditions become more difficult. To-day every individual, institution, and local authority which has scrap in its possession can be assured of a market. The National Federation of Iron and Steel Scrap Merchants guarantees to find a purchaser for all iron and steel scrap offered by the public or by public authorities. If there were any evidence that this guarantee were not fully implemented in letter and spirit, I would be in favour of the Ministry of Supply taking powers itself to purchase and dispose of such scrap.

"Moreover, I understand from the Scrap Merchants' Federation that they will ensure not merely the purchase, but the removal of any substantial quantity of scrap on private premises or on municipal premises where its continued presence may be causing serious inconvenience. Small quantities are handled by the local authority in urban areas, and in country districts through the Village Dumps Scheme. Broadly speaking, the presence of scrap in municipal yards, village dumps and other dumps does not mean that, as is sometimes supposed, the scrap is neglected and unwanted. These dumps are, in effect, scrap reserves. The metal can remain conveniently in this form until it is wanted for preparation for the furnaces. A considerable stock of scrap is normally held, and in present circumstances it is necessary to build up good stocks for later months when demand from the works may increase and the accumulation of scrap in dumps will be more difficult for climatic and other reasons. If, however, there is good reason to suspect that scrap is being hoarded, that is, unreasonably held for speculative or other improper purposes, and if the matter is reported to me, I will at once requisition it.

No Hold-up

"I have conferred with representatives both of the National Federation of Scrap Iron and Steel Merchants and of the Independent Scrap Iron, Steel and Metal Merchants' Association. I am satisfied that there is at present no hold-up caused by the arrangement whereby steelworks purchase scrap only from members of the Scrap Merchants' Federation. This Federation was formed before the war, one of the conditions of membership being willingness to forgo the highly profitable export markets available in Germany and elsewhere. It now performs a useful function in organising a difficult and heterogeneous trade. Merchants who are not members of the Federation can sell scrap to members at exactly the same price as the steelworks themselves pay for the quantity in question. If the Federation member makes any profit on such transactions, he does so by building up and reselling larger consignments which, for sound technical reasons, bring a higher price. If a non-member sells to a member a quantity large enough to realise the maximum price per ton, the non-member receives this price, and the merchant resells the quantity to the mill without profit. The metal goes direct from the non-member's store to the mill without additional handling. There is no 'rake-off' and no intermediary of any kind, whether a so-called agency firm or any other, operating between the merchant who is a member of the Federation and the steelworks; statements to the contrary are without foundation.

Direct Sale to Steelworks

"I propose, however, to watch this position carefully and to see that no bottle-neck does, in fact, arise, that the Federation really can control its members and that it is in a position to prevent any abuses or attempts at speculation. The National Federation has undertaken to facilitate the entry of new members and to put no unreasonable obstacle in the way of increased membership.

"In case there is any doubt, let me say that public authorities are now free to sell their scrap direct to the steelworks if they wish, provided it is in substantial quantities and has been suitably sorted. I counsel them, however, to make sure of their ability to deal with the many technical questions of handling and disposal that are involved. Some of them, I am sure, have this ability. Any who are not confident of it might be wise to consider using the services of a merchant.

"The view that I have formed is that the difficulties that may arise to cause possible obstruction later on in the free flow of scrap to the mills are not primarily difficulties of a commercial kind at all, but mainly questions of labour and transport. Both these matters are now having close attention. It is hoped to arrange very shortly for an additional supply of labour for sorting, breaking and transporting metal, and the Ministry of Labour has already taken steps to this end. The Merchants' Federation is moving to secure the setting up of a Conciliation Board to regulate labour conditions. Arrangements are also on foot to provide against any possible shortage in transport facilities.

"At the present time, I am assured that the mills are receiving their full requirements of scrap. Their intake is 50 per cent. above what it was at the beginning of the war and the stocks in merchants' yards are actually lower than they then were. The problem is therefore to provide against future difficulty rather than to remove present obstacles. To this end we need plans for securing special forms of scrap on a large scale.

"A scheme for securing disused tram-rails is already in operation, and arrangements are being made by the Ministry for a comprehensive survey of all heavy scrap in the form of railings, derelict factories, pitheads and other obsolete structures.

"Let me say in plain terms that I will tolerate no obstacle of any kind, whether commercial or technical, to the free flow of scrap to the mills. The public can respond to salvage appeals and can turn out their old iron from lofts and attics, fields and gardens, in full confidence that it will all go where it is wanted, and that even if it spends a few weeks in a dump on its way to the steelworks, it is very much better there than lying about in the odd corners from which the public is asked to bring it out and make it available."

Iron-Plating of Specimens for Microscopical Examination

In a Paper which MR. E. A. JENKINSON, of the National Physical Laboratory, Teddington, has prepared for presentation to the Iron and Steel Institute, an account is given of a method of supporting fractured surfaces of creep and tensile test-pieces so that longitudinal sections can be prepared for microscopical examination right up to the fracture. After a brief discussion of the disadvantages of first a fusible alloy mounting and then a thick copper electrodeposit, experimental work on the production of heavy electrodeposits of iron with suitable qualities is described. The general effect of temperature and current density on the microstructure of the plating is illustrated by micrographs. It has been found possible to obtain uniform and adherent deposits free from gas cavities both on bright test-pieces and on those which have suffered some degree of oxidation.

Plating at temperatures below 80 deg. C. tends to produce gas cavities, brittleness and internal cracking of the deposit. At 85 deg. C. the optimum conditions exist and the deposit is tough, very adherent and free from defects such as gas cavities. At higher temperatures the bath is more difficult to operate, owing to excessive evaporation, and the deposits are somewhat coarser and less clean than those produced at 85 deg. C. It has been found that high current densities tend to produce gas cavities and fine grain size with consequent brittleness. The best conditions of current density are found to be from 5 to 20 amps. per sq. ft.

Catalogues Received

Personal Protective Products. Safety Products, Limited, 44, Hatton Garden, London, E.C.1, as distributors in this country for Willson Products, Inc., of Reading, Pa., U.S.A., have sent us an exceptionally comprehensive catalogue produced by the latter concern. The brochure runs to 40 pages and is profusely illustrated. Whilst the main contents are devoted to goggles, there are extensive sections covering welding helmets, industrial respirators and gas masks of many types, and abrasive blasting helmets. The recent developments in goggles are such that whilst affording a maximum of protection for the eyes, due cognisance is taken of comfort for the wearer under every possible condition. We understand that so long as supplies last, copies of this catalogue are available to our readers on application to Safety Products, Limited.

Blast-Furnace Gas Cleaning. The Whessoe Foundry & Engineering Company, Limited, of Darlington, have issued a brochure which describes and illustrates an important installation in Scotland. The method used involves cleaning 6.5 million cub. ft. of gas per hr. down to a specified cleanliness of 0.009 grains per cub. ft. The plant was started up last August and the results obtained are consistently below this figure. The gas is pre-cooled to 30 deg. C. and partially cleaned. Then it passes to the disintegrator which effects further cleaning, but as a certain amount of spray is included, the gas passes to a spray separator. Finally, an integral part of the plant is that which deals with the pumping and disposal of the effluent. The process can easily be followed from the illustrated description contained in this very interesting brochure.

The Fatigue and Impact Strengths of Cast Iron

(*Continued from page* 93.)

very good notch toughness in irons with a high phosphorus content by keeping the carbon content low.

A recent investigation was also carried out by Piwowarsky[6] on high-duty grey cast iron. Two irons containing approximately 2.5 per cent. total carbon and 2.7 per cent. silicon were subjected to a single blow impact test and to an impact-strength test on rings made of the material. In the first type of test, a test-piece 55 by 6 by 6 mm. was used, the blow being struck by a light pendulum, while in the ring test a hammer of 13 kgs. weight was dropped from a height of 45 mm., giving a blow energy of 585 mm.-kg. on to a ring 122 mm. external diameter, 10 mm. wide and 8 mm. thick. Both cast irons were subjected to three different heat-treatments before testing. The first treatment consisted of heating to 850 deg. and cooling in oil, the second of a similar treatment followed by reheating to 450 deg. C. and cooling in a lead bath, and the third an oil-quenching followed by tempering at 650 deg. C. and cooling in air.

The results obtained for the tests are given in Table VIII, together with the compositions of the irons. The single blow tests show little variation and show how difficult it is to form conclusions from a test of this type. More destructive results are obtained from the ring tests, which indicate more clearly the influence of the various heat-treatments, and show that by suitable treatment it is possible to produce great improvements in the properties of cast iron required to resist shock—improvements which, if judged by the single blow test, would appear to be slight.

FRY'S *Solder Reference Tables*

TINMANS SOLDERS

Grade B.S.S.	Melting Temperature	Tensile Strength tons/sq."	Elongation %	Brinell Hardness
A	185° C.	4.9	20	13.9
B	205° C.	4.4	67	12
C	230° C.	4.1	63	11.3
D	255° C.	3.8	53	8.7
F	210° C.	3.8	69	12
K	185° C.	4.0	52	13.9

DIPPING SOLDERS

Number	Recommended Bath Temperature	Weight	
		lb./cubic inch	lb./cubic feet
1	330° C.	0.332	573.7
2	350° C.	0.352	608.25
3	400° C.	0.372	642.8

We undertake regular analyses and the periodical cleaning of dipping tank metals and supply special fluxes for this work.

HIGH TEMPERATURE SOLDER

for hot water appliances, armatures, and any soldered joint to resist temperatures of over 100°C (212°F)

Number	Melting Range	Brinell Hardness		
		at 15° C.	at 100° C.	at 180° C.
H.T.3	235/240° C.	10.3	5.45	3.0
L.S.1	305/312° C.	7.1	5.35	3.0
L.S.2	305° C.	7.1	4.95	3.0

FUSIBLE SOLDER

Grade	Melting Temperature		Grade	Melting Temperature	
Fry's No. 2 Alloy	70° C.	158° F.	Fry's Tube Bending Alloy	71° C.	160° F.
Fry's No. 9 Alloy	93° C.	203° F.			
Fry's No. 15 Alloy	138° C.	281° F.	Fry's Alloy for Die and punch mounting	120° C.	248° F.
Fry's No. 17 Alloy	124° C.	256° F.			

SOLDERING FLUXES

TYPE A "PROTECTIVE FLUXES"		TYPE B "ACTIVE FLUXES"
"Alcho-re" (Soldering Fluid) / (Soldering Paste) — A.I.D.	Non-Corrosive Safety Fluxes	"Frysol"— Tinning Salt / Soldering Fluid / Soldering Paste Flux — Fluxes for all General Soldering, Dipping, etc.
"Fry's Oleic Acid No. 9" — W.O. CWD/275/C / I.N.O. K/767	Non-Corrosive Safety Fluxes	
"Fryolene" Paste Flux — Rapid action, Non-corrosive Flux for Ferrous and Non-ferrous Metals		
Fry's Zinc Flux ... Non-corrosive Flux for Zinc and Zinc Alloys, and Galvanized Iron		

Further details, samples, technical leaflets and metallurgical advice on request

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The Week's News in Brief

Trade Talk

THE ADDRESS of the Aluminium Controller is now: Southam Road, Banbury.

THE CARRON COMPANY, of Falkirk, has been granted Warrant of Appointment as ironfounders to H.M. the King.

WILLIAM DOXFORD & SONS, LIMITED, the Sunderland shipbuilders and marine engineers, celebrate their centenary this year.

THE MINISTRY OF AIRCRAFT PRODUCTION has purchased a large privately-owned seaplane in New York in which 3½-ton cargoes of aluminium will be transported from the United States to Great Britain twice a week.

IN CONNECTION with the offer to stockholders of J. Brockhouse & Company, Limited, of 150,000 £1 ordinary shares at 30s., it is announced that stockholders have taken up 89 per cent. of the issue, which is intended to finance plant extensions and provide further working capital.

SIX REGIONAL STEEL INSPECTORS have been appointed by the Iron and Steel Control to investigate reports of misuses of steel. They will recommend the immediate cessation of work on any unauthorised or non-essential structure, in accordance with a recent Order issued by the Ministry of Supply.

THE MINISTER OF LABOUR, having taken powers to direct any person in the United Kingdom to perform any service which, in the opinion of the Minister, he is capable of performing, is now amending the unemployment insurance regulations in order to prevent insurance benefit from becoming a shelter to men who do not obey his direction. There are also penalties for refusing to obey a direction.

FAIRBAIRN LAWSON COMBE BARBOUR, LIMITED, Urquhart Lindsay & Robertson Orchar, Limited, of Leeds, associated firms, and R. Goodwin & Sons (Engineers), Limited, Stoke-on-Trent, have joined the British Cast Iron Research Association. The former concerns are represented by Mr. J. K. Anderson and the latter by Mr. J. S. Goodwin. Fawcett, Preston & Company, Limited, of Bromborough, Wirral, Cheshire, have joined the Association as trade members.

PROPOSALS for the establishment of a workshop for the manufacture of broad-gauge locomotives are likely to be placed before the Standing Finance Committee for Railways in India, states "Commerce." The choice of location of the proposed workshop lies between Jamalpur on the East Indian Railway and Kanchrapara on the Eastern Bengal Railway. As according to the decision of the Railway Board the locomotives are to be of Indian make, except for the patent parts, detailed investigation has been undertaken to ascertain if full provision to that effect has been made. It is also gathered that preliminary designs for the manufacture of jigs and fixtures needed in the manufacture of locomotives are being got ready. It is estimated that the cost of production of XE locomotives, complete with boiler and tender, would be Rs. 98,000, and this is stated to be cheaper than that of imported locos by 20 per cent.

Steel and Malleable Castings Export Groups

Two newly-formed Export Groups cover sections of the foundry industry. The Malleable Castings Export Group has Mr. A. E. Hurst as chairman, while Miss L. Verity is secretary. The address is c/o National Association of Malleable Ironfounders, Tudor House, Bridge Street, Walsall, Staffs.

The Steel Castings Export Group has been formed with Mr. W. B. Pickering as chairman. Peat, Marwick, Mitchell & Company, of Williams Deacon's Bank Chambers, Church Street, Sheffield, 1, are undertaking the secretarial work.

Application for Trade Mark

The following application to register trade marks has been taken from the "Trade Marks Journal":—

"ALPIX," "FOLGUM" and "REFINOX"—Chemical products for use in the metallurgical industry; tempering substances and chemical preparations for use in soldering, etc. F. & M. SUPPLIES, LIMITED, 21/23, Coldharbour, London, E.14.

Personal

MR. WILLIAM FINLAYSON, manager of the Lancefield Foundry Company, Limited, non-ferrous founders, of Glasgow, has been appointed a Justice of the Peace for the County of the City of Glasgow.

MR. E. M. CURRIE, Dr. A. B. Everest, Dr. J. E. Hurst and Mr. J. G. Pearce form the Technical Advisory Committee to the Director of Iron Castings in the Iron and Steel Control of the Ministry of Supply.

MR. ARNOLD TIPPER, M.Sc., has resigned from the services of the Fordath Engineering Company, Limited, of West Bromwich, to take up an appointment with Wilmot-Breeden, Limited, motor accessory engineers, Birmingham.

MR. W. H. GREAVES has been appointed representative for Scotland by Edgar Allen & Company, Limited, of Sheffield, consequent upon the retirement of Mr. A. MacPhail. Prior to his appointment, Mr. Greaves was assistant representative in the same area.

MR. A. HARASOWSKI, the well-known Polish foundry manager, is now employed in a Glasgow foundry. Together with his wife, who is an experienced journalist, they are producing a daily newspaper for the Polish forces and refugees in this country. It is a four-page production, three of which carry news, whilst the fourth is Mr. Harasowski's section and is devoted to teaching English to his readers.

MR. FRED CLEMENTS, managing director of the Park Gate Iron & Steel Company, Limited, has been appointed chairman of the company in succession to Sir William Bird, who has resigned. Mr. Clements, who is a Vice-President of the Iron and Steel Institute, will continue as managing director. Mr. Ashley S. Ward (joint managing director of Thos. W. Ward, Limited, Sheffield) has been appointed deputy chairman of the Park Gate Company.

MR. RALPH ALSOP, general manager of the Consett Iron Company, Limited, it is announced, will now resume his duties on the completion of his work of building up the organisation of the Control of Steel Supplies. Mr. Alsop has been Deputy Controller in Charge of Steel Supplies for the Ministry of Supply since the outbreak of war and in official and industrial circles his success in building up the now smoothly running machinery of distribution has been widely appreciated. An official statement recalls that: "In May last year, Sir Edward George intimated to the directors of the Consett Iron Company, Limited, his intention to retire at October 31, 1939, from his positon of general manager, and Mr. Alsop was appointed to the position as from November 1, 1939. At the outbreak of war, however, Mr. Alsop, by previous arrangement, was loaned to the Ministry of Supply for the important position of Deputy Controller of Iron and Steel Supplies, and, in the circumstances, Sir Edward George agreed to continue as general manager for a limited period. The period then visualised having now more than expired, and Sir Edward wishing to be relieved of the heavy responsibility, it has become necessary that Mr. Alsop should take up his duties as general manager, and the Minister of Supply has reluctantly agreed to release him." Mr. J. M. Duncanson will follow Mr. Alsop as Deputy Controller.

Machine Tool Prices Controlled

The Control of Machine Tools (No. 2) Order, 1940, dated July 25, 1940, has been issued by the Minister of Supply under Regulations 55 and 98 of the Defence (General) Regulations, 1939. It states that no person in the United Kingdom shall pay or receive for any new machine tool produced in the United Kingdom any price other than a price fixed by the Minister of Supply by Order. It also establishes a price for machine tools produced in the United Kingdom and sold for use in the United Kingdom of a type set out in the schedule to the Order and identical with those on offer for sale during a standard period, which is taken as the six months ended December 31, 1935. Intending purchasers of machine tools should make themselves familiar with the terms of the Control of Machine Tools (No. 2) Order, 1940, copies of which can be obtained from H.M. Stationery Office, or from any bookseller.

Reports and Dividends

Hadfields, Limited—Interim dividend of 7½ per cent.

James Howden & Company, Limited—Dividend of 15 per cent. for the year to April 30 last.

Howard & Bullough (Securities), Limited—Profit for the year to March 31 last, £41,928; brought in, £1,235; dividend for the year of 4 per cent. on the ordinary shares; carried forward, after preference dividend, £2,913.

International Diatomite Company, Limited—Profit for the year ended March 31, after providing £4,000 for taxation, £6,791; brought in, £1,118; to reserve, £3,000; dividend of 4 per cent., £3,750; carried forward, £1,158.

Walter Somers, Limited—Full report for year to March 31 shows: Profit from trading account, after making provision for taxation, £67,321; net profit, after charging £4,784 for debenture interest, £6,099 as provision for debenture redemption, £4,905 for A.R.P., and £13,520 for depreciation, £37,696; dividend on the 6½ per cent. employees' cumulative preference shares, £186; brought in, £19,553; dividend of 1s. per share on the ordinary shares, £10,937; to insurance reserve, £2,000; to general reserve, £12,000; to employees' trust fund, £4,000; carried forward, £28,125.

Company Meeting

Davy & United Engineering Company, Limited

The accounts for the past year reflected the steady progress made by the company since 1935, said MR. E. J. Fox at the annual meeting of Davy & United Engineering Company, Limited. Whereas the trading profit for the year ended March, 1936, was £26,000, there had been a steady improvement from year to year since then until in the year which they were considering the trading profit reached the total of £123,000. Their plant and machinery had been employed to the greatest possible measure, and to provide for the additional wear and tear they had increased the rate of depreciation for the year. Export contracts to the value of almost £750,000 had been satisfactorily completed, and a considerable number of mill, press and general engineering plants installed at home. Certain initial steps had been taken to combine their Sheffield and Glasgow organisations by standardising as far as possible workshop methods and routine, but the plans which the board had in mind had to be carried out slowly until conditions returned to a more normal state. Their Middlesbrough business, which they regarded as a valuable auxiliary to Sheffield and Glasgow—occupied in the production of rolls for rolling mills and of steel castings of all descriptions from the smallest up to 10 tons in weight—was fully occupied during the year.

Contracts Open

Bradford, August 22—Special pipes and castings, steam and gas tubing and fittings—wrought iron and steel, wrought iron and steel bars, plates, etc., bolts, nuts, brass main gas cocks, during 12 months ending September 30, 1941, for the Town Council. The Gas Engineer, Britannia House, Bradford.

Haverhill, August 15—Supplying and laying 1,800 yds. of 7-in. and 2,800 yds. of 6-in. cast-iron water mains, for the Clare Rural District Council. Mr. H. Brown Thake, surveyor, 10, High Street, Haverhill, Suffolk. (Fee £3 3s., returnable.)

Pontypridd, August 14—Stand-by emergency pumping plant, to be of a portable type and include turbine pump, direct-coupled high-voltage motor, starting gear and all accessories, and be capable of raising three million galls. of water per day against a pumping pressure of 550-ft. head, for the Mid-Glamorgan Water Board. Thomas & Morgan & Partners, consulting engineers, 23, Gelliwastad Road, Pontypridd.

Forthcoming Events

AUGUST 14.

British Cast Iron Research Association:—Meeting of Research Committee at 2.30 p.m. and of Council at 3.45 p.m., at Chamber of Commerce, New Street, Birmingham.

Ironfounders' National Confederation:—Meeting of Executive Committee at 11 a.m., and of Main Committee at 2.30 p.m., at Euston Hotel, London, N.W.1.

Institute of Vitreous Enamellers

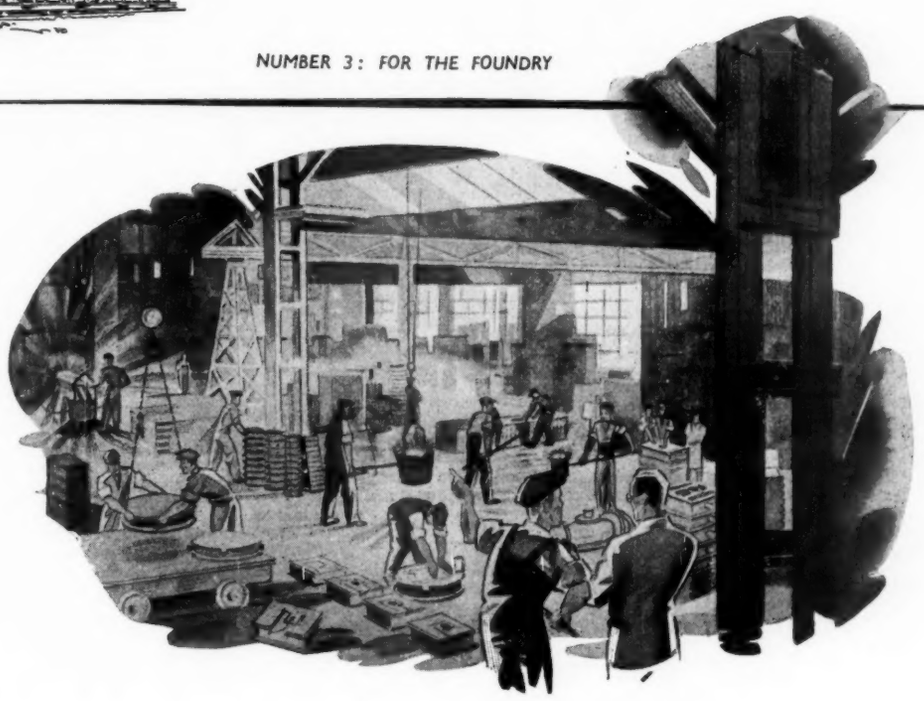
AUGUST 16.

Council:—Meeting at 49, Wellington Street, London, W.C.2, at 2 p.m.

REFRACTORIES ON PARADE

THE TECHNICAL KNOWLEDGE GAINED FROM RESEARCH IS AVAILABLE TO ALL USERS OF SANDS AND REFRACTORIES FOR THE FOUNDRY

NUMBER 3: FOR THE FOUNDRY



From Quarries situated throughout England, Scotland and Wales General Refractories Ltd. has available a range of more than 50 moulding and silica sands to meet every need.

With these quarries located so as to serve the main industrial areas, it is often possible to supply from a centre in close proximity to the user, and thus transport costs are reduced to a minimum.

A few of the sands that we produce :—

YORKSHIRE ZENITH
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MAXIMUM CORE
SOUTHPORT SEA
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Raw Material Markets

The current week in normal times is the most popular period for holidays at the iron and steel works, but on Monday and throughout the week, with few exceptions, there has been full-time operations at the producing works. Generally speaking, any interruption of output has been dictated by the necessity for carrying out repairs to plant. It is hoped that the maximum number of workers will be able to snatch short rest periods from time to time, but no general closing down of works will be permitted. There could be no clearer proof of the workers' resolve to win the war at whatever cost than their co-operation in respect to the questions of holidays and overtime. Heavy engineers continue to be fully engaged on Government contracts, while more work of national importance is being found for the light-castings section. Owing to the difficulty of acquiring iron for ordinary domestic products, the light foundries are still poorly situated on the whole, but hopes are entertained that a combination of Government orders and a freer distribution of iron for the manufacture of goods for the export market will assist this branch of industry in the near future.

Pig-Iron

MIDDLESBROUGH—A considerable change has been brought about in the Cleveland foundry trade during the past few months; largely due to specifications from shipbuilders, marine and constructional engineers, there is now no shortage of work, whereas earlier in the year many foundries were unable to run their plant on a full-time basis. There is very little Cleveland foundry iron available, as makers have to cope with the large requirements of basic iron. Fortunately, adequate tonnages of iron are forthcoming from the Midlands under licence to satisfy an expanding consumption. Hematite furnaces on the North-East Coast are disposing of their entire outputs without delay. The requirements of the local steel plants are heavy, while the Control authorities are responsible for the distribution of the surplus iron, for which there is a keen demand.

LANCASHIRE—Consumption of iron from Derbyshire and Staffordshire furnaces is heavy in the Lancashire area, but quite satisfactory tonnages are being railed to meet the needs of priority users. Machine-tool makers, heavy electrical engineers and other specialised branches have full order-books, while there is quite a substantial call in the aggregate from general engineers and jobbing foundries. The dullest section is still the light-castings branch and consumption here is restricted. Only a very small amount of iron is released for the ordinary domestic trade of this section, while the export trade, also, is quieter than is desired, although an expansion in shipments at an early date is not out of the question in view of the importance of retaining and regaining foreign connections. There is a steady call for West Coast brands of hematite.

MIDLANDS—The supply of high-phosphorus iron is still barely adequate to meet the demand. Basic iron is now being produced by many furnaces formerly on foundry numbers, and it may be that some of these will have to revert to high-phosphorus iron before long, as, owing to the heavy call on low-phosphorus iron and hematite, more of the former grade is being used. Stocks are on the small side, as production has been at a comparatively low ebb for a considerable time past. The light-castings trade, usually the largest consumer of high-phosphorus iron, remains rather poorly placed, and order-books are unusually light in view of the small quantities of iron at the disposal of the trade. By making adjustments in their mixtures where possible users of low-phosphorus iron and hematite are able to operate their plant satisfactorily, but the Control are having to distribute supplies with additional care, and only urgent demands which come within the priority category are quickly met.

SCOTLAND—The position of the foundry trade here is unchanged, heavy engineering concerns being overwhelmed with specifications, especially from shipbuilders, while the light-castings makers, on the whole, cannot maintain continuous production. Supplies of foundry iron are coming through quite freely from the English Midlands, No. 3 foundry being 115s. 6d., f.o.t. furnaces. At one time local ironfounders obtained their iron from the Cleveland area of the North-East Coast of England, but this source of supply dried up owing to the furnaces there concentrating on the production of basic iron for the steelworks.

Coke

Rarely has the demand for foundry coke been maintained so consistently throughout the summer months as has been the case this year, and it is certain that considerable stocks have been accumulated by most of the major consumers. Ovens are still briskly employed, and deliveries are being made freely. Buyers generally are covered by forward contracts, which are subject to payment being made at the rate in force at the time of delivery. The current quotation, for delivery to Birmingham and Black Country stations, is 55s. 6d. per ton, but when fixing this price the Control did not stipulate any time limit before a further revision would be made.

Steel

Such is the demand for steel that works in many instances are working long shifts with no break at the week-ends. The strain of such conditions on the workers is fully realised and, with the influx of additional employees and a system of staggered shifts, it is hoped to reduce the number of hours worked by each employee. War requirements account for the major part of the record outputs now being returned by the United Kingdom steel industry, but licences are granted for other work in exceptional circumstances, while the expansion of the export trade is recognised as being of the utmost importance, and further progress in this respect may be expected now that the various Export Groups linked with the steel trade are functioning. It is difficult to discriminate between the various steel products, as there is such a heavy all-round pressure on the productive capacity of the works.

Scrap

Although there continues to be the keenest pressure for deliveries of ferrous scrap, the fact should not be lost sight of that the present rate of deliveries is not less than 50 per cent. in excess of the pre-war level. Consumption continues to expand, and the need for increasing still further the supply of scrap is obvious. In this connection the Ministry of Supply is making strenuous efforts and larger tonnages should be placed at the disposal of the consuming plants in the near future. Substantial resources are also available outside the United Kingdom, but it is not desirable to place shipping space to this purpose unless the situation becomes really serious at home; as yet, there is no shortage of material, and the present problem is to expedite the collection of the scrap.

Metals

Non-ferrous metals generally continue to play a big part in the munitions programme. Copper consumption is heavy and is likely to remain so, both in this country and in the United States, where the domestic market is firm. An easier tone developed in the tin market prior to the week-end, buyers being reserved following some good activity both in this country and on the other side of the Atlantic.

Mr. Jesse H. Jones, the federal loan administrator, announced in New York on Friday that the Metal Reserve Company had purchased 137,000 tons of manganese and 2,975 tons of tin. The recent agreement between agents of the U.S. Government and the International Tin Committee provided for the purchase of 75,000 tons of tin.

Mr. W. H. Gartsen (Henry Rogers, Sons & Company) estimates that the total visible supply of tin on July 31 was 32,659 tons, against 27,522 tons at the end of June. The carry-over in the Straits Settlements was 2,819 (1,962) tons, while the carry-over at principal European smelters was 2,750 (1,920) tons.

According to the "Statistical Bulletin" of the International Tin Research and Development Council, Fraser Road, Greenford, Middlesex, world production of tin in June is estimated at 19,600 tons, against 17,500 tons in May. The total production in the first half of 1940 was approximately 102,900 tons, compared with 63,200 tons in the first half of 1939. Tin consumption in the United Kingdom totalled 15,740 tons in the first six months of 1940, against 10,341 tons in the corresponding period of 1939, showing an increase of more than 52 per cent. United States deliveries increased by 68½ per cent. from 30,000 tons in the first half of 1939 to 50,609 tons in the first half of the current year. World stocks of tin, including smelters' stocks and carry-over, were 41,211 tons at the end of June, compared with 40,783 tons a month before and with 39,368 tons at the end of June, 1939.

London Metal Exchange tin prices this week have been as follow:—

Cash—Thursday, £267 15s. to £268. Friday, £265 to £265 5s.; Monday, £265 15s. to £266 5s.; Tuesday, £266 10s. to £266 15s.; Wednesday, £266 10s. to £266 15s.

Three Months—Thursday, £267 10s. to £267 15s.; Friday, £266 5s. to £266 10s.; Monday, £266 to £266 5s.; Tuesday, £266 10s. to £267; Wednesday, £266 5s. to £266 10s.

Large tonnages of zinc are being used in connection with armaments manufacture, and there is no substantial surplus available to ordinary domestic users. Nevertheless, traders dealing with the export market are hopeful of acquiring additional supplies in the near future in connection with the Government's desire to expand the overseas market. The lead supply position continues to be very satisfactory.

Non-Ferrous Scrap

As announced in our last issue, the Minister of Supply is taking steps to ensure that the best use is made of scrap metal (other than iron and steel). The official announcement states that the Controller of Non-ferrous Metals will, until further notice, be prepared to buy: (*a*) Rough copper produced from works in this country assaying not less than 97.25 per cent. copper at a price of £53 per ton, f.o.r. sellers' works; (*b*) rough copper assaying 99 per cent. copper or over, produced from works in this country, at a price of £54 per ton, f.o.r. sellers' works, for delivery within three months of the date of each contract; payment net cash when the copper is placed at the disposal of the Non-ferrous Metals Control, together with certified assay showing the copper content.

The Controller is also prepared to buy pig-lead refined in this country, for delivery within three months of the date of each contract, at the price of £22 10s. per ton, f.o.r. sellers' works, provided that the lead content is 99.98 per cent. or over and that the impurities do not exceed the following limits: Antimony, 0.003 per cent.; copper, 0.0015 per cent.; bismuth, 0.01 per cent.; tin, 0.0001 per cent.; zinc, 0.0001 per cent.; iron, 0.0003 per cent.; arsenic, trace; silver, 5 dwts. Payment net cash when the lead is placed at the disposal of the Non-ferrous Metals Control, together with certified analysis.

Inquiries should be addressed to the Controller, Non-ferrous Metals Control, Grand Hotel, Rugby.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

522,251 HURST, J. E., and BRADLEY & FOSTER, LIMITED. Production of unchilled castings of white cast-iron.

522,252 BRISTOL AEROPLANE COMPANY, LIMITED, and GADD, E. R. Manufacture of austenitic ferrous-alloy articles.

522,280 SPRINGORUM, K. Manufacture of bearing-shell blanks for composite cast bearings.

" PIGS IS PIGS "

There are, unfortunately, Founders who say " What's in a Name," and who, surprisingly enough, manage to produce excellent castings without the assistance of our special pig irons. But there are a great majority who know that the name of Warners is a guarantee of dependability, of accuracy of analysis and of soundness of casting and that the high-duty irons required to-day are more easily produced by the use of Warner pig irons. To such Foundry men "Pigs is Pigs"—

BUT

Warner's IS Warner's

May we have your enquiries ?

WARNER AND CO., LTD., CARGO FLEET, MIDDLESBROUGH

RAW MATERIALS—PRICE LIST

Wednesday, August 7, 1940

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent.	60	10	0
Black hot-rolled wire rods	65	10	0

TIN

	£	s.	d.
Standard cash	266	10	0
Three months	266	5	0
Settlement	266	10	0
Official average Cash, July	265	15	2 1/13
Do. Three Months, July	265	9	4 4/13
Do. Settlement, July	265	14	6 1/13

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western"	26	10	0
Refined and electrolytic	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b.	30	0	0
Pipes, home	34	0	0
Do. export, f.o.b.	30	10	0
Tea lead (nom.)		—	

ALUMINIUM

Ingots	£110
Wire, 10g.	nom.
Sheets	nom.
Circles, 20/24g.	nom.

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises	28	7	6

ANTIMONY

	£	s.	d.
English, 99%	99	0	0
Foreign Regulus, duty paid	99	0	0
Chinese, prompt shipment, c.i.f.	80 0 0 to 83	0	0

QUICKSILVER

	£	s.	d.
Quicksilver, ex-w'hse London	54	10	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.
Finished bars, 22% tungsten	4s. 4d.

Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3¼ to 1/9¼
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

* Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

(all prices nominal)

	£	s.	d.
Ferro-silicon—			
25%	18	10	0
45/50%	21	10	0
75%	31	0	0
Ferro-vanadium—			
35/50%	15/6 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	6/- lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	—		
Max. 1% car.	—		
Max. 0.5% car.	—		
70% carbon-free	—		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot	175	0	0
Ferro-cobalt, 98/99%	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	0	0
76/80% packed	19	10	0
Metallic manganese—			
94/96% carbon-free	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths	3	16	6 to	3	19	0
Heavy machinery cast iron			4	6	6	
Ordinary heavy cast iron			4	1	6	
Cast-iron railway chairs			4	6	6	
Medium cast iron			3	17	9	
Light cast iron			3	13	0	
MIDDLESBROUGH—						
Short heavy steel	3	14	3 to	3	16	9
Heavy machinery cast iron			4	11	3	
Ordinary heavy cast iron			4	8	9	
Cast-iron railway chairs			4	8	9	
Medium cast iron			3	19	0	
Light cast iron			3	14	0	
BIRMINGHAM DISTRICT—						
Short heavy steel	3	9	3 to	3	11	9
Hematite ingot mould			5	10	9	
Heavy machinery cast iron			4	11	9	
Ordinary heavy cast iron			4	7	0	
Cast-iron railway chairs			4	7	0	
Medium cast iron			3	19	9	
Light cast iron			3	14	9	
SCOTLAND—						
Short heavy steel	3	14	0 to	3	16	6
Heavy machinery cast iron			4	13	9	
Ordinary heavy cast iron			4	8	9	
Cast-iron railway chairs			4	13	9	
Medium cast iron			3	16	9	
Light cast iron			3	11	9	

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration: 50 tons and upwards over three months 2s. 6d. extra.

PIG-IRON*

N.E. COAST (d/d Tees-side area)—	
Foundry No. 1	123/-
,, No. 3	120/-
,, No. 4	119/-
Forge No. 4	119/-
Hematite No. 1	131/-
Hematite M/Nos.	130/6
N.W. COAST—	
Hem. M/Nos. d/d Glas.	131/-
,, d/d Birm.	142/6
MIDLANDS (d/d Birmingham dist.)—	
Staffs No. 4 forge	121/-
,, No. 3 fdry.	122/-
Northants forge	118/6
,, fdry. No. 3	119/6
,, fdry. No. 1	122/6
Derbyshire forge	121/-
,, fdry. No. 3	122/-
,, fdry. No. 1	125/-
Phosphorus 0.5% to 0.75%	129/6
Phosphorus 0.1% to 0.5%	132/6
SCOTLAND—	
Foundry No. 1, Grangemouth	119/9
,, No. 3, Grangemouth	117/3
Cleveland No. 3, Glasgow	123/-
,, ,, Falkirk	120/-
Scottish hem. M/Nos. d/d	131/-
SHEFFIELD (d/d district)—	
Derby forge	118/6
,, fdry. No. 3	119/6
Lincs forge	118/6
,, fdry. No. 3	119/6
W.C. hematite	136/6
LANCASHIRE (d/d eq. Man.)—	
Derby fdry. No. 3	125/-
Staffs fdry. No. 3	125/-
Northants fdry. No. 3	123/6
Cleveland fdry. No. 3	125/-
Cylinder and Refined Irons	
North Zone	168/-
South Zone	170/6
Refined Malleable	
Birmingham and S. Staffs	165/6
Cold Blast	
South Staffs	217/-

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

	£	s.	d.
BASIC:			
Soft, u.t., 100-ton lots	10	10	0
Tested, up to 0.25% C.	10	15	0
Tested, 0.25 to 0.33% C.	10	17	6
Tested, 0.33 to 0.41% C.	11	0	0
Hard (0.42 to 0.60% C.)	11	17	6
,, (0.61 to 0.85% C.)	12	7	6
,, (0.86 to 0.99% C.)	12	17	6
,, (1% C. and up)	13	7	6
Silico-manganese	14	5	0
Free-cutting	12	10	0
SIEMENS MARTIN ACID			
Up to 0.25% C.	13	15	0
Case-hardening	14	12	6
Silico-manganese	14	10	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C.	12	2	6
Basic hard, 0.41 to 0.60% C.	12	10	0
Acid, up to 0.25% C.	14	5	0

Other Semi-products, etc.

Tin bars	10	7	6
Sheet bars	10	7	6
*Wire rods, soft basic	15	4	0
,, hard basic	18	12	6
,, free-cutting	17	12	6
,, acid	22	3	6

* Subject to rebate.

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections plates joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast)	14	3	0
Boiler plts. (N.E. Coast)	15	0	6
Chequer plts. (N.E. Coast)	15	13	0
Angles, over 4 un. ins.	13	13	0
Tees, over 4 un. ins.	14	13	0
Joists, 3 in. × 3 in. and up	13	13	0
Rounds and squares, 3 in. to 5½ in.	14	13	0
Rounds under 3 in. to ¼ in. (untested)	15	8	6
Flats—over 5 in. wide	13	18	0
,, 5 in. wide and under	15	8	6
Rails, heavy, f.o.t.	12	15	6
Hoops	16	3	6
Black sheets, 24 g. (4 t. lots)	19	7	6
Galv. cor. shts. (,,)	22	12	6
Galv. flat shts. (,,)	23	2	6
Galv. fencing wire, 8g. plain	24	7	6

FINISHED IRON

	£	s.	d.
CROWN IRON:			
England and Wales	15	2	6
Scotland	15	2	6
Ireland, f.o.q.	15	15	0
No. 3 BARS:			
England and Wales	12	5	0
Scotland	13	7	6
Ireland, f.o.q.	12	17	6
No. 4 BARS:			
England and Wales	12	15	0
Scotland	13	12	6
Ireland, f.o.q.	13	7	6
STRIP:			
England and Wales	16	10	0
STAFFS MARKED BARS, f.o.t.	18	0	0

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated, July 16, 1940.

	Dols.
No. 2 foundry, Phila.	24.84
No. 2 foundry, Valley	23.00
No. 2 foundry, Birm.	19.38
Basic, Valley	22.50
Malleable, Valley	23.00
Grey forge, Valley	22.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00
Wire rods	2.00
	Cents.
Iron bars, Chicago	2.25
Steel bars	2.15
Tank, plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., No. 24	3.50
Wire nails	2.55
Plain wire	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

Welsh foundry	42/6 to 44/-
,, furnace	31/6 to 33/-
Durham foundry	39/6
,, furnace	33/5
Scottish foundry	42/6 to 47/6
,, furnace	31/6

TINPLATES

f.o.b. Bristol Channel ports

I.C. cokes	20 × 14	per box	27/6 to 28/-
,,	28 × 20	,,	55/- to 56/-
,,	20 × 10	,,	40/- to 42/-
,,	18¾ × 14	,,	30/-
C.W.	20 × 14	,,	27/6
,,	28 × 20	,,	55/-
,,	20 × 10	,,	40/-
,,	18¾ × 14	,,	29/-

NON-FERROUS SCRAP

(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clear untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ½ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.

	Per lb.
Solid drawn tubes	13½d.
Brazed tubes	15½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods	8½d.

COPPER TUBES, etc.

Solid drawn tubes	14½d.
Brazed tubes	14½d.
Wire	9½d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	13½d.
Wire	15½d.
Rods	15½d.
Tubes	20½d.
Castings	17d.

Delivery 3 cwt. free.
10% phos. cop. £35 above B.S.
15% phos. cop. £40 above B.S.
Phosphor tin (5%) £40 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

A COMPARISON OF CAST-IRON SCRAP PRICES

Average Monthly Prices of Cast-iron Scrap in the Principal Districts in the Years 1934–40

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
SCOTLAND (Heavy Machinery)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1934	2 14 2	2 17 9	2 18 5	2 18 2	2 15 5	2 15 9	2 14 3	2 15 0	2 15 9	2 15 0	2 15 8	2 16 3	2 16 0
1935	2 15 5	2 15 8	2 15 10	2 16 4	2 16 10	2 17 0	2 16 9	2 16 9	2 17 0	2 16 11	2 19 11	3 2 7	2 17 5
1936	3 4 8	3 9 10	3 10 11	3 11 10	3 10 8	3 9 10	3 9 2	3 8 9	3 8 11	3 9 2	3 10 0	3 13 3	3 9 9
1937	3 15 0	4 2 10	4 6 2	4 9 9	4 14 9	4 15 0	4 15 0	4 15 0	4 15 0	4 15 6	4 15 0	4 13 3	4 11 0
1938	4 11 3	4 11 3	4 8 3	4 5 7	4 1 2	3 17 10	3 15 0	3 14 4	3 12 7	3 14 10	3 18 0	3 18 0	4 0 8
1939	3 19 0	3 19 0	3 19 0	3 19 0	4 1 1	4 2 6	4 2 6	4 3 2	4 5 5	4 3 0	4 3 0	4 3 0	4 1 8
1940	4 3 0	4 3 0	4 13 0	4 13 0	4 13 7	4 13 9	4 13 9	—	—	—	—	—	—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
N.E. COAST (Heavy Qualities)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1934	2 12 7	2 15 1	2 13 7	2 11 6	2 11 11	2 13 9	2 11 0	2 10 6	2 11 3	2 11 10	2 13 9	2 13 3	2 12 4
1935	2 12 2	2 13 0	2 12 7	2 13 0	2 12 9	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 16 10	2 12 10
1936	3 0 0	3 1 10	3 1 8	3 2 2	3 4 6	3 3 9	3 5 9	3 4 1	3 5 11	3 6 3	3 6 8	3 7 10	3 4 2
1937	3 10 6	3 14 9	4 2 6	4 3 9	4 6 3	4 7 6	4 7 6	4 7 6	4 6 0	4 5 0	4 5 0	4 5 0	4 3 5
1938	4 5 0	4 2 6	4 0 0	3 18 1	3 11 3	3 10 0	3 10 0	3 9 8	3 11 0	3 13 1	3 15 0	3 13 6	3 14 11
1939	4 0 0	4 0 0	4 0 0	4 0 0	4 2 6	4 1 6	4 0 0	4 0 0	4 0 2	4 0 6	4 0 6	4 0 6	4 0 6
1940	4 0 6	4 0 6	4 10 6	4 10 6	4 11 1	4 11 3	4 11 3	—	—	—	—	—	—

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
S. WALES (Heavy Cast Iron)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1934	2 6 10	2 8 9	2 7 8	2 6 6	2 7 6	2 8 0	2 6 10	2 6 7	2 8 0	2 8 2	2 9 1	2 11 5	2 7 1
1935	2 11 3	2 11 4	2 11 1	2 11 3	2 12 0	2 11 1	2 11 1	2 11 0	2 12 2	2 13 10	2 14 5	2 14 8	2 11 9
1936	2 16 3	2 18 7	2 18 9	2 19 2	2 18 7	2 18 7	2 19 0	2 19 0	2 18 9	2 19 0	2 19 2	2 19 0	2 18 8
1937	3 4 1	3 9 8	3 9 3	3 9 0	3 9 0	3 9 0	3 9 0	3 9 0	3 8 9	3 9 9	3 9 9	3 9 11	3 8 10
1938	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0
1939	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 3 5	3 9 0	3 9 0	3 9 0	3 3 7
1940	3 9 0	3 9 0	3 19 0	3 19 0	3 19 7	3 19 9	3 19 9	—	—	—	—	—	—

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(A remittance should accompany instructions.)

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FOUNDRY FOREMAN desires change. Expert knowledge of Loam, Dry Sand, and Green Sand, Cupola, etc. Good organiser. Excellent references.—Box 416, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

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SITUATIONS VACANT AND WANTED—*Contd*

EMPLOYMENT REGISTER.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

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IDLE PLANT won't help the country!

For the successful prosecution of the war the need for Plant and Machinery is as urgent as the need for men. Have you any surplus plant which might be set to work in the national interests? *We will either purchase outright, or negotiate the sale for you on a commission basis*

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6 ft. dia., 10 tons per hr.

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Macdonald Jolter, table 72 in. by 54 in.

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Tabor Portable Shockless Rollover, table 40 in. by 30 in.

Tabor ditto, table 27 in. by 20 in.

Tabor 21 in. by 16 in. squeeze.

Zimmerman Type R.P.W. 2 Jolt Squeeze turnover, table 36 in. by 20 in.

Mumford Type (Jackman) Swing Headpress, 13 in. by 15 in. and 14 in. by 16 in.

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